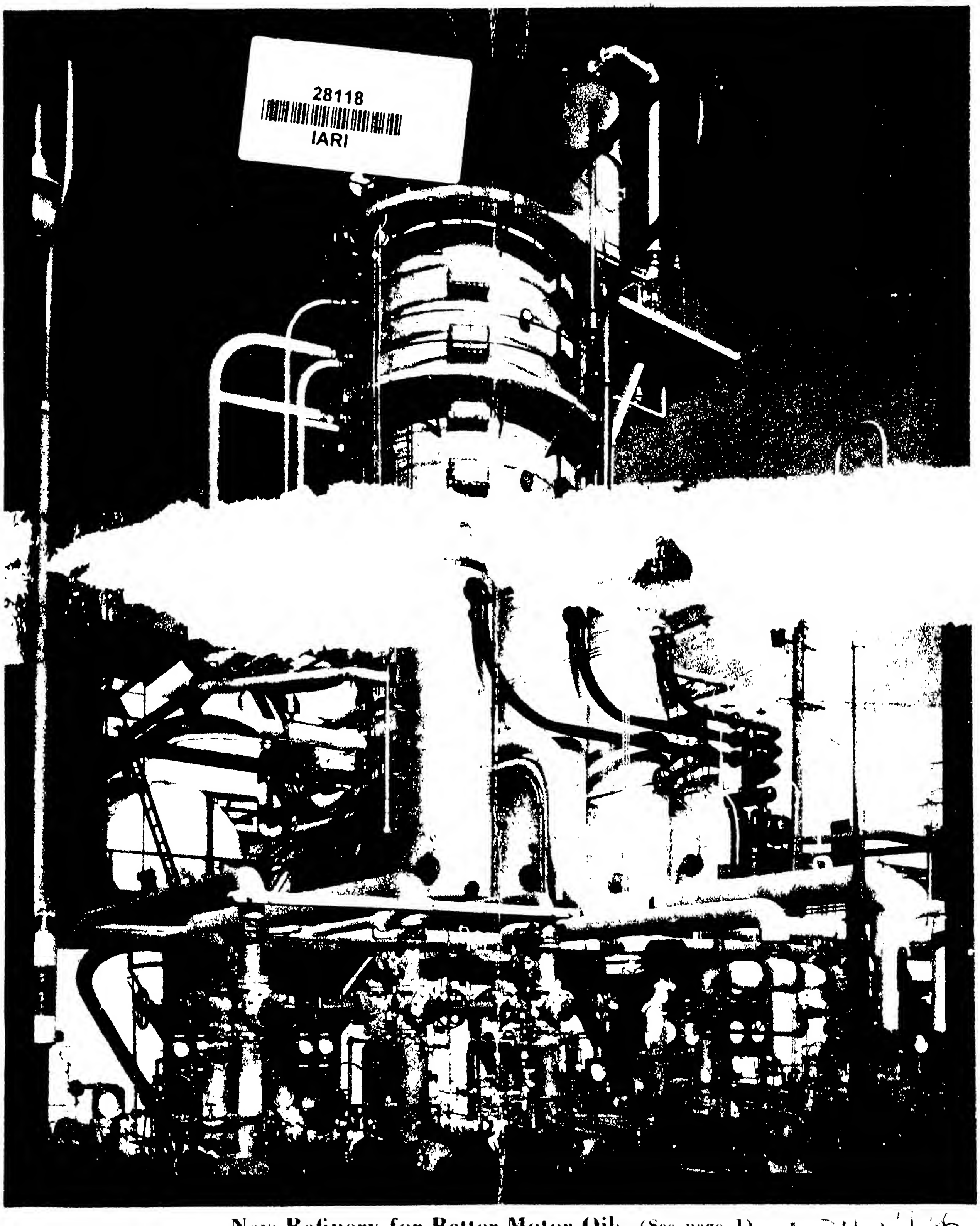
SCIENTIFIC AMERICAN



New Refinery for Better Motor Oils (See page 1)

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SCIENTIFIC AMERICAN

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

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COVER

In a new refining plant which has been constructed in California to refine oil by the process described in the article starting on page 19, is the vacuum distillation unit shown on our cover. The vacuum fractionating column in the center background is designed to produce several grades of oil.

The SCIENTIFIC AMERICAN DIGEST

28118/136

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ACROSS THE EDITOR'S DESK

Our 90th Anniversary!

LAST month we promised an important announcement in our January issue. Here it is: 1935 is SCIENTIFIC AMERICAN'S 90th Anniversary Year! To us this year is naturally a prideful one. It marks an important milestone in the successful publication of a journal of world-wide prestige—90 years of publication by the family of the original editor. To you, 1935 promises important monthly events.

It is customary at anniversaries to look backward, to reminisce. By doing so we could uncover, in yellowed pages of bygone days, a wealth of interesting scientific fact and comment and of predictions, long since fulfilled in glorious measure, of practical industrial applications which we saw would follow various pieces of scientific research. We could carry our review of scientific achievement through four of the six major wars of the United States and through the difficulties of panics and depressions. We could tell of dark and uncertain days when progress seemed to stand still for want of courage and vision; and in turn, of high flying days when industrial expansion, if not sound progress, set the world in a fever. We could remind the world of many master strokes of genius which were also interpreted in pages now yellowed by time.

We prefer, however, to look to the future, sparingly toward the past. Present achievements come fast upon the heels of others and time is too short for reminiscence; progress today and tomorrow are too vital to admit of delay in interpretation and evaluation of new strokes of genius. The year 1935 is indeed our 90th Anniversary Year, but SCIENTIFIC AMERICAN is modern, is 90 years young. Thus devolves upon us, more than ever before, the job of mentor to thinking, science-minded people; the Age of Science is here, and science is taking its place as one of the strongest cultural influences of the day.

During this year 1935 momentous events will occur—in all fields of human endeavor. In science, and particularly in industrial applications of scientific findings, these events will have a very definite bearing on our future social and economic existence. This is borne out by the fact that even during the depression years, the much talked about "children of depression" have shown the progressiveness of the practical men of science. Therefore as new ideas, new products, and new processes are created in this swift march of science, SCIENTIFIC AMERICAN will carry on with outstanding articles in the true 1935 manner.

Orson D. Munn
Editor and Publisher

Personalities in Industry

J. C. LINCOLN

AN ominous rat-a-tat-tat once spelled death and destruction on the battle fields of France. Peace put an end to both the clatter and the destruction of the machine gun. In peace time another sort of rat-a-tat-tat, still destructive to human nerves, has betokened progress. Research bids fair to supplant this staccato voice, in large measure, with a sibilant hiss of greater progress. But even in this process of supplanting, there has been war—a war of words, of claims and counter-claims, of citations of strength of materials tables, of industrial research, a war between far-sighted men and skeptics, engineers, manufacturers, steel men.

There is no doubt that J. C. Lincoln has been the outstanding general in this war of electric arc welding against the rivet hammer. Our own records, as war correspondent on this peace-time front predicting success for arc welding, show this clearly. Moreover, the recent award to Mr. Lincoln of the Samuel Wylie Miller Medal "in recognition of his great contribution to the advancement of the science of electric fusion welding" by the American Welding Society, completes the record.

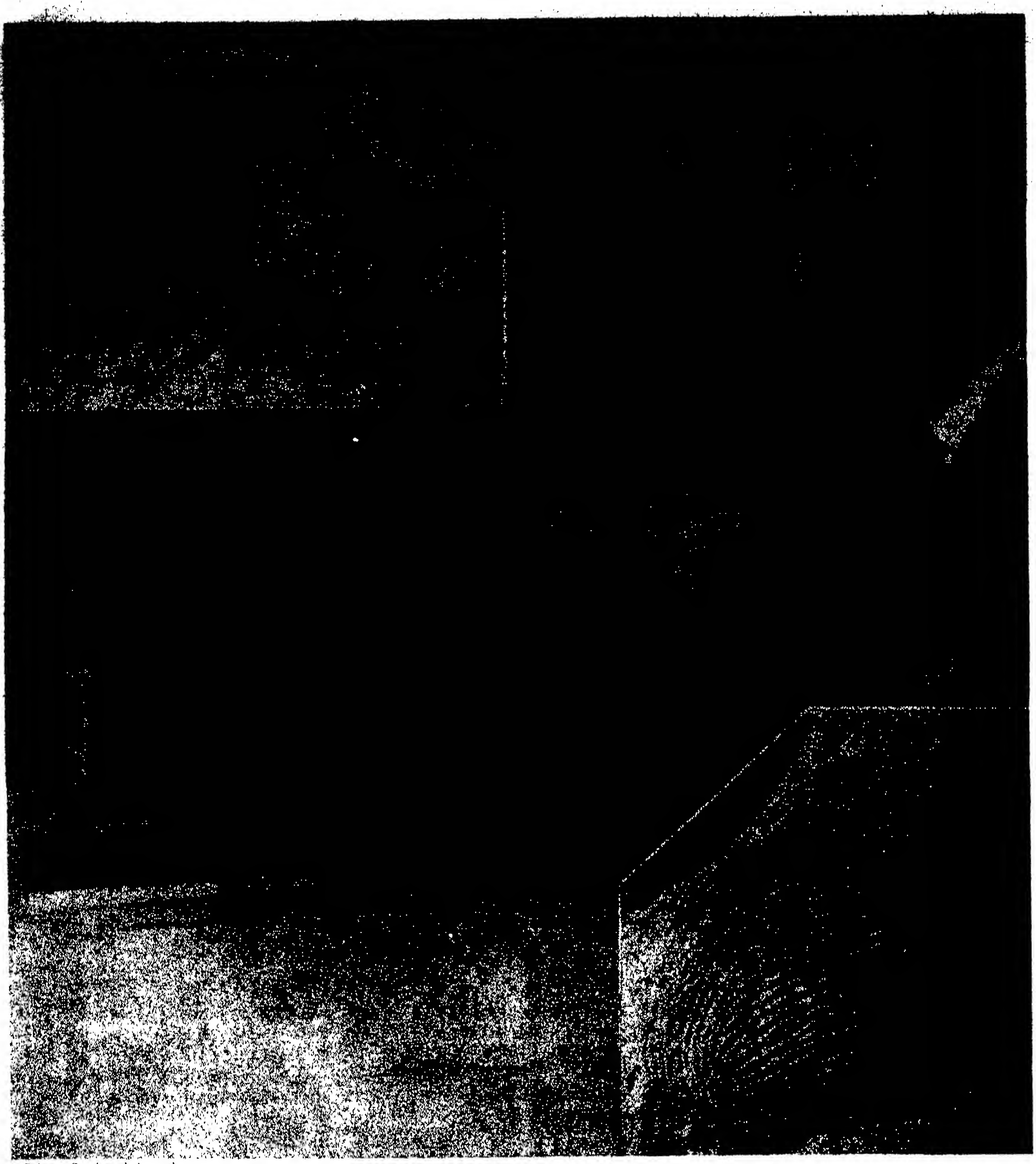
Mr. Lincoln knows the electric arc and its capabilities for, after receiving his degree from Ohio State University, he joined, in 1888, the staff of Charles F. Brush, inventor of the arc light. Later he became affiliated with the Elliot-Lincoln Company, one of the pioneer manufacturers of electric motors. In 1896, with this company as a nucleus, he formed the Lincoln Electric Company, of which he is now Chairman of the Board. Producing, in 1907, the first variable voltage welding machine, the company under his leadership rapidly improved the technique of arc welding. He was the first to carry the electric arc into the structural field.

Today arc welding is rapidly finding new applications. Mr. Lincoln explains thus:

"The application of arc welding has changed our concepts in many ways regarding methods of manufacture. From the point of view of repairs it has given us the much-desired putting-on tool which has made possible low cost repair in almost all cases instead of high cost replacement.

"The second application which appeals to the public strongly is its application in building construction. The elimination of the noise of the riveting hammer has appealed to many nerve-racked neighbors. The thing which has been largely overlooked, however, is the fact that arc welding makes it possible to make a joint as strong or stronger than the parent metal, which rivets cannot possibly do. Therefore, the amount of material needed for a structure is very considerably reduced. This is particularly important in marine construction where the smooth outline possible with welding will materially increase ship speeds. This construction also will very materially reduce all costs of construction because of the cheaper method of doing the job and less material required for the same result.

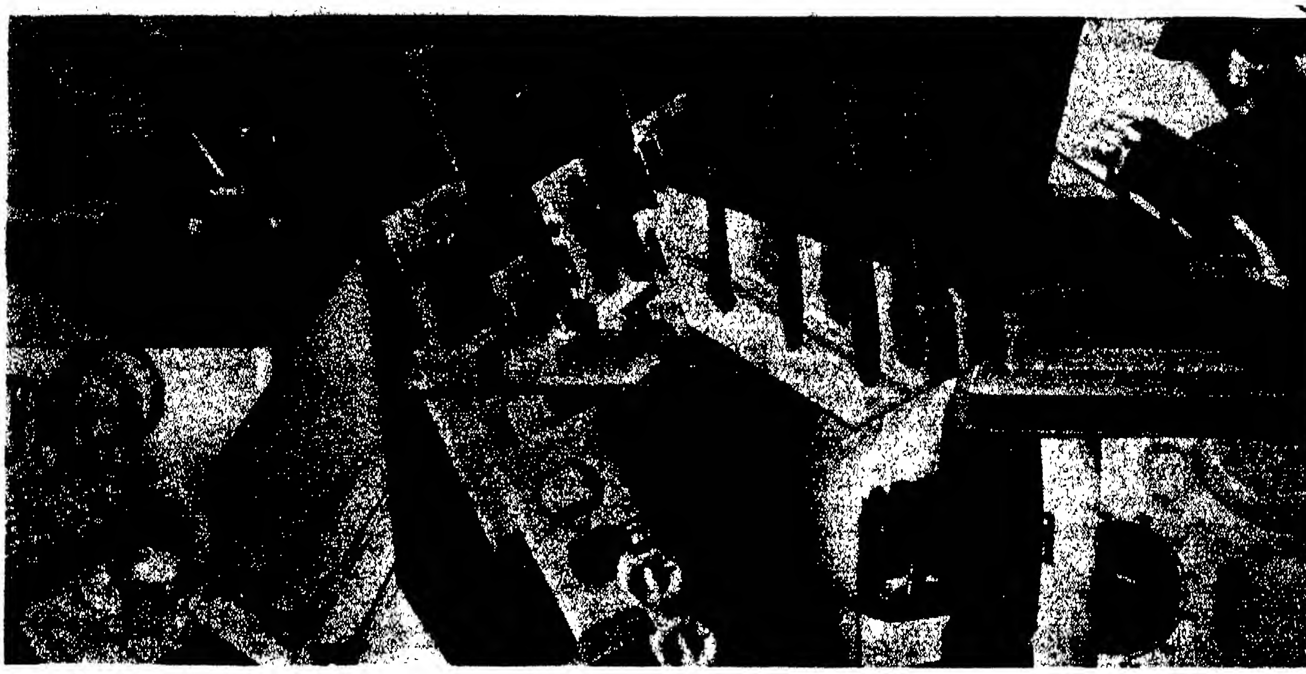
"In spite of the attractiveness of these two applications, the one which is by far most important, insofar as size of the application, is the replacement of steel and iron castings by welded structural steel. This is the application in which arc welding is used much more than in the two cases above. This application gives a lighter, stronger, unbreakable, cheaper part than is possible by the casting method. This will also result within a comparatively short time in the elimination of a large part of foundry work. It will at the same time increase the amount of steel used. At the present time probably about one and one half million tons of castings per year have been eliminated by this process. It is probable that it will eliminate a total of about 75 percent of castings as made prior to the time of the advent of welding. This process will also entirely eliminate the rivet as a method of joining structures. It will also largely increase the utility of worn and broken parts."



Science Service photograph

FINGERPRINTS OF 3000 YEARS AGO

THE long arm of archeological science has reached back 3000 years to obtain a record of ancient potters who left fingerprints in their clay wares. The prints were detected by Dr. William F. Bade, shown above examining dishes which he unearthed at the ruins of Mizpah, in Palestine. In wine jars, cups, and lamps he discovered prints that were so plain that the work of different potters could be sorted. The prints shown in the corners of the illustration are those of the same potter impressed on two different objects. In some cases pottery from different levels of the town's ruins were discovered to be the work of the same potter. Mizpah is the Biblical city where Saul was chosen king.



PLASTICS IN INDUSTRIAL USES

PLASTICS COME OF AGE

Age 66 . . . Structural and Insulating Qualities . . . Shoes and Dental Plates . . . Fireproof Wall Panels . . . Transparent or in Colors . . . Compete With Wood and Metals . . . An Even More Plastic World Seen

By PHILIP H. SMITH

FEW are the residents of these United States who do not make daily use of some plastic. Upon rising, the individual may drink from a plastic tumbler, manipulate a plastic handled toothbrush and shaving brush, and button plastic buttons. When he climbs into his car he grasps a plastic ball on the gearshift lever, glances at a plastic instrument panel and glides away in a vehicle which functions with the aid of plastics. Once at his office he may lay his cigarette on a plastic ash tray and reach for a plastic telephone receiver. And so throughout the day—yet the plastics industry has little more than passed through infancy.

From this brief listing of items, plastics can be fairly well identified, but we are no nearer to knowing what they are. Examination of them reveals little or nothing. What makes a plastic and why?

Plastics is the name given to a more or less arbitrarily chosen group of substances which, when properly compounded and treated, become plastic and can be molded or cast to shape. The plastics group embraces nitro-cellulose, rubber, phenolic and urea resins, cellulose-acetate, shellac, casein, and styrol, glyptal, and vinyl resins.

So many and varied are the plastics on the market today the layman may well ask "why?" Do these products compete for identical markets? And the manufacturer contemplating their use may carry the question a step further and ask "which one?" Both questions can be answered by stating that many plastics are partially competitive, but each type has properties differing more or less from all others. Each type was developed with specific uses in view, or, having resulted from laboratory experiments, certain properties were recognized and new markets developed. The properties which recommend the various plastics are: dielectric strength, heat, chemical, and moisture resistance, color, ease of fabrication, tensile and bending strength, and impact resistance, or combinations of such properties.

Plastics came into existence just 66 years ago when John Wesley Hyatt, searching for a substitute for ivory for making billiard balls, invented Celluloid, a nitro-cellulose product. But it wasn't until 1907 when Dr. L. H. Baekland discovered how to control the union of phenol, or carbolic acid, and formaldehyde to make the synthetic resin known as Bakelite, that one could speak of plastics and a plastics industry. It was that discovery, precipitating development of synthetic resin plastics, which gave rise to a producing group and an allied group of fabricators—a host of specialists in molding. Statistics bear this out for during the past 20 years plastics production has risen steadily. Now, following a few years of very rapid growth the industry has an annual output conservatively valued at 50,000,000 dollars.

TO explain the phenomenal growth of recent years it is necessary to consider the chemistry of materials and processes, for commercial expansion is the natural outcome of technical progress linked with other factors which will be mentioned later.

Plastics can be divided into two groups — thermo-setting and thermoplastic. The first group undergoes a chemical change when heated to curing temperature in a mold. The resultant

product is permanently hard, infusible, insoluble and non-reversible. The thermo-plastic type, when molded, softens in heat without chemical change and hardens to form. This latter type can be remolded with heat. Aside from these two types are plastics molded cold with a binder. Chief among the thermo-setting type are phenolic, hard rubber, and urea. In the thermo-plastic group fall cellulose nitrate and acetate, shellac, Plioform—a new rubber base material—and vinyl, styrol and glyptal compounds.

Plastics are either molded or cast. In molding, the compounds are placed in a mold cavity in the form of powder, granules, or chips and the proper heat and pressure are applied. The product comes from the mold with a permanent gloss needing no surface treatment. This process is fast, and complex form can be given to the finished piece so that molding offers many economies in production. Cold molded plastics receive similar treatment except that the charge is pressed without heat and the formed piece cured outside the mold by baking in an oven. The advantage of this type lies in speed of molding and in certain savings in cost of molds, since rapid press work can be obtained with single cavity molds and the curing done in mass. In general, three types of binders are used for cold molded plastics—asphalt where lowest cost is sought; phenolic resin; and cement or silica-lime, these last two being used where high refractory properties are desired.

LAMINATED plastics can be classed with the molded group. They are made in sheets, rods, and tubes. Sheets of fabric or paper stock are impregnated with the plastic, then piled upon each other to any desired thickness and pressed, the resins fluxing in the process and taking a permanent set as in molding. Tubes are made by winding impregnated fabric onto mandrels and either rolling under heat and pressure or molding with heat in steel molds, while rods are produced by machining laminated sheets or by winding impregnated fabric on a wire, then removing the wire and molding.

The casting of plastics is performed by pouring a liquid plastic into a mold. Cast plastics are usually cast in sheets, rods or tubes ready for machining to form, much as metals are handled. Rods, for example, are widely used for buttons, which are machined to form.

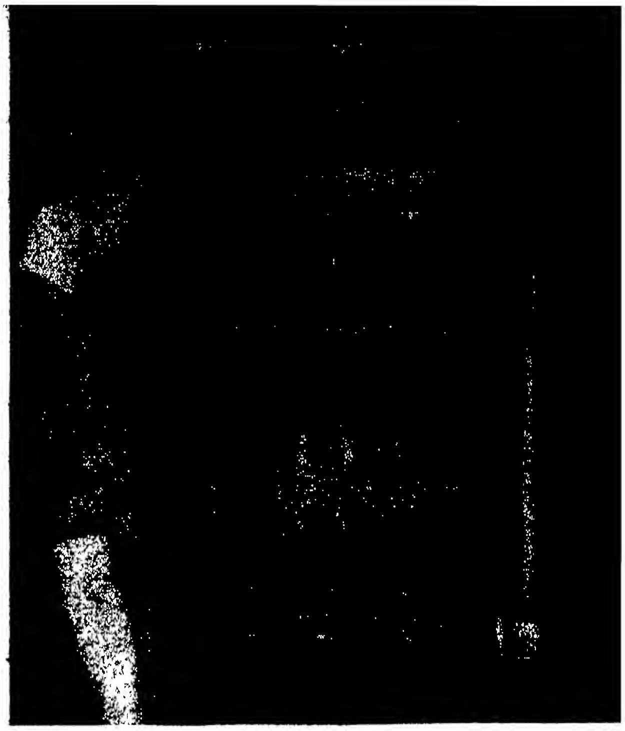
When Dr. Baekland introduced Bakelite, he made available a plastic which, unlike nitro-cellulose, was non-combustible. This original phenolic type with its high dielectric properties found prompt application, but it could not be made in light colors without heavy pigmentation and the resin tended to darken with age. So the next step in the phenolic field was to get permanently light colors, translucency and transparency, and this gave rise to the cast phenolic. Later came the urea products.

All this development work took years to accomplish but success was crowned with a utility value almost beyond imagination. Manufacturers discovered that they had at their disposal virtually a new material—something which combined mechanical and structural qualities to make it competitive with wood and metal or to be used in combination with both, something which lent itself to mass production use and so attractive as to aid in the creation of its own market. Indeed, the eye-appeal and pleasant surface feel of plastics have produced sales

results which largely explain the phenomenal growth of the past few years. Commercial records are replete with instances of success achieved with plastics.

Though the discovery of new plastics has brought about some replacement of the older types, that is of minor import in comparison with the boost it has given the industry. Each plastic has made a distinct contribution and this will be seen from discussion of some of the newer forms.

Consumption of the phenolics has increased by leaps and bounds and today they are the most widely used of modern synthetic resin plastics. No adequate statistics are available, but a hint of this growth is given in figures which show output of synthetic resins of coal-tar origin, mainly used in plastics, multiplying more than 20 times in the past dozen years. The molded type using such fillers as wood flour (sawdust), mica, asbestos, and fabric, has high bending and tensile strength, excellent heat resistance, and performs well in the presence of weak acids, alkalis, oil, and water. The public knows this material under many names, among them Bakelite, Durez, Resinox, and Textolite. The laminated type can be made stronger than cast iron and this property of strength coupled with fine insulating properties has given it wide industrial application for such items as gears, bushings, plates, washers, non-metallic shims, pump valves, electrical parts, and



***Above:* Making phenolic objects in a multiple die under hydraulic pressure. *Left:* A pile of the raw material from which such objects are molded**

the like. This type will be recognized by such well known names as Bakelite, Micarta, Formica, and Celoron, among others.

The cast phenolic plastics are used where lightness and brilliancy of color are paramount or where transparency or translucency is desired. This type is perhaps best known under the names Catalin, Bakelite, and Marblette.

STILL newer types of plastics are those basing on urea. This is a thermo-setting plastic best known by such trade names as Beetle, Plaskon, and Unyte. Urea plastics have several properties which particularly recommend them. They are tasteless and odorless, which explains their use for dishes, and they can be made translucent or in light colors without heavy pigmentation. Solka, the new cellulose product of spruce forests, is most often used as a filler for it provides strength without impairing the translucency or brilliancy of the light colors, but paper products are also used. Urea plastics come in molded, cast, and laminated form. Molding around metal for articles where hard usage demands great strength, such as for automobile door handles, has just been announced. In this instance the plastic replaces metal plating.

Styrol and vinyl resin plastics are as yet used in much smaller quantities than the phenolics or ureas. The former compares with amber or quartz as a dielectric and by some is considered superior. The latter features transparency, translucency, and bright colors. It has machining and dielectric properties of a high order.

Rubber is still used on a very large scale as a plastic, but the phenolics have tended to replace the hard molded

forms. Among outstanding qualities are its capacity to withstand shock and resist abrasion. Quite recently a thermoplastic, rubber-base material was introduced by Goodyear under the name Plioform. Plioform is molded in much the same manner as the phenolic resins, but it has the quality of resisting moisture and possesses high dielectric properties.

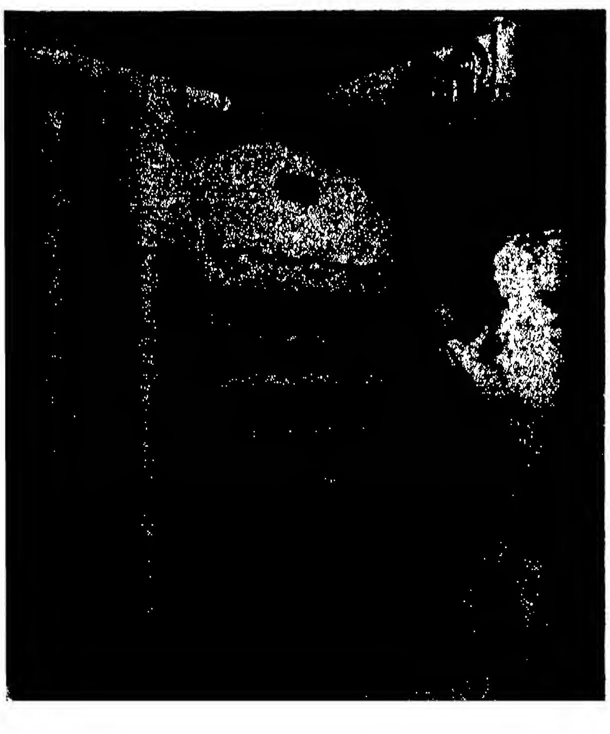
NO description of plastics would be complete without specific mention of the nitro-cellulose and cellulose-acetate types. The former, called pyroxylin, and best known to the public by such names as Celluloid and Pyralin, has wide use as a decorative material. In 1933 close to 12,000,000 pounds were produced. It is usually formed in sheets, rods, and tubes for machining, but it can be molded. Cellulose-acetate is much like pyroxylin, but it does not burn explosively and therefore, sometimes substitutes for it. Its high dielectric properties and low water absorption make it an excellent insulator. It is made in practically all colors and is perhaps best known commercially as Lumarith, Tenite, and Masuron.

Plastics' first big use was as a nonconductor in the electrical field and as an imitation product for such items as pipe bits, umbrella handles, and the like. Only with the advent of the cast type came the conception of a plastic as a material in its own right with endless commercial possibilities, and coincident with this came a cheapening of the basic materials and improvement in the making of molds, leading to lower fabricating cost. Then the race was on.

Viewing the present position of plastics one might think they had reached a stage of complete exploitation. Certainly there is hardly any commercial endeavor in which they fail to play a part, but widespread as is their use the limit is not yet reached. There is room for development—along chemical lines in discovering new types and refining existing ones; along commercial lines in finding new uses and extending present applications. We may hazard the opinion, held by many, that search will be made to uncover a cheaper resin which will cut costs and open the way for much larger consumption. Plastics are not cheap materials. Prices range all the way from about 15 cents to several dollars per pound, depending on the type and form.

Let us for the moment consider the future of plastics without reference to cost, since possible application precedes consideration of cost. What direction will expansion take? There is no certainty of direction; one must use one's imagination. It sounds absurd but consider the material. Plastics combine structural and insulating qualities, need no finishing, possess attractive color and pleasant surface feel, will not rust or tarnish, and have all the other properties already mentioned.

Below: Layers of fabric or paper, impregnated with plastic varnish, are pressed to yield a laminated material. _Right:_ Some uses for this product



Draw upon these facts and possible applications come to mind. Maybe they have been thought of already; maybe they haven't. Someone, for example, recently thought to use plastics for photo-elastic stress studies. Now, forms to be studied are made up in a transparent plastic, polarized light is passed through them and the stress is measured by the refraction of the light. Certainly any material which can thus be used to promote science, which can be used for the box toes of shoes, for dentures, and serve as a chinaware, as a table top, as a substitute glass to transmit ultra-violet rays, and as the transparent binder in non-shatterable glass, simply puts it up to human ingenuity.

If we consider plastics as competitors of wood and metal we find undeveloped fields immediately. The principal ones are house furnishings and building construction. Plastics can be made into furniture by combining a resin with wood flour; they can be used as veneers for tables, cabinets, and the like, or in laminated form for the solid tops of tables and bars. Such plastic equipment is fire-resistant and will not mar from ordinary wear and tear or from cigarette butts and alcohol.

THE use of plastics in building has hardly begun, yet its possibilities are known. Panels are offered by many producers, among them Bakelite, Formica, and Micarta. These panels can be produced to simulate stone, wood, or tapestry for walls, store fronts, or elevator cars. Carbide and Carbon Chemicals Corporation, experimenting in co-operation with the Pierce Foundation, having the pre-fabricated house in mind, found vinyl resins practical in the manufacture of doors, wall panels, and floor tile.

It does not take great imagination to visualize houses of the future exhibiting plastics in a much wider number of applications. Floors, doors, and walls would be fire-resistant, unmarrable and in attractive color. Lighting fixtures will feature translucent plastics. Even windows would be made of plastics, translucent or transparent, depending upon the desirability of the view. And much the same application would take place in public buildings, stores, and the like. We can look forward with certainty to an increased use of plastics in transportation equipment where non-inflammability and light weight would be an asset in airplane, railroad train, and steamship construction.

If this comes to pass, and any great development hinges very much upon successful efforts to lower costs, then the production volume of this relatively new material will rise much more rapidly than it can by subsisting upon a vast array of small items, though they are produced in mass. And we shall live even more in a plastic world.

●

EDITOR'S NOTE: *Unless listed below, trade names mentioned in this article are identical with company names. No attempt has been made to list all producers of plastics.*

Beetle (American Cyanamid), Celoron (Continental-Diamond Fibre), Durez (General Plastics), Lumarith (Celluloid), Masuron (J. W. Masury & Son), Micarta (Westinghouse), Plaskon (Toledo Synthetic Products) Pyralin (DuPont), Tenite (Tennessee Eastman), Textolite (General Electric), Vinylite (Carbide & Carbon Chemicals).

Photographs courtesy makers of Bakelite, Plaskon, and Beetle.

INDOOR PHOTOGRAPHY

With Ordinary Cameras . . . Super-Sensitive Film . . . Inexpensive Flood-Lights . . . Flash-light Bulbs

By A. P. PECK

ALL you need to take indoor snapshots of the youngsters before you tuck them in at night, of fun at parties, and other home scenes, is a camera with $f/6.3$ or faster lens, a few inexpensive Photoflood lamps, and a roll of super-sensitive film. With cameras having slower lenses (even those of the box type that have "time" adjustment) you can make quick time exposures.

Preparations are few and simple. Depending on your lens, you can take indoor night pictures in one of three ways.

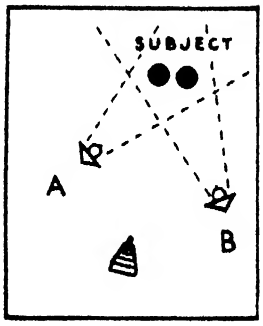
1. For *snapshots* (1/25) with an $f/6.3$ lens at full opening, use super-sensitive film and three flood lamps as shown at the right.

2. With slower lenses, use Photofloods in the same way but place camera on a table and make short time exposures.

3. An easy method for successful indoor pictures at night with single lens and box type cameras is simply to replace the bulb in any readily portable home light with a Photoflash lamp. Remove the shade and hold lamp about six feet from subject, a foot or so higher than the head. Set camera for "Time," place it on a table, open the shutter, flash light, close the shutter, and you've got your picture. Inexpensive reflector units are convenient and make the light more effective.

Striking silhouette photographs are easy for the amateur photographer to make, results such as the above being obtained with the set-up illustrated at the right. A white sheet is stretched tightly across a doorway between two rooms. With two Photoflood bulbs in a floor lamp with shade removed, an exposure of two seconds will suffice for single-lens cameras. Double-lens cameras at $f/8$ will require one second, and $f/6.3$ lenses about ½ second. With Photoflash bulbs, set shutter for time, open it, flash the bulb and close shutter. Use fast film. Silhouette photographs are most interesting showing profiles of the subjects

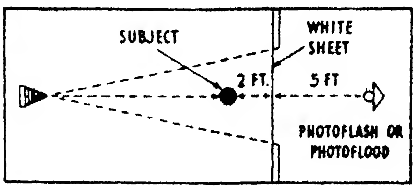
FOR pleasing pictures, especially close-ups, there should be a proper balance of light. It is usually best to place flood lamps on each side of the subject, arranged to give somewhat more illumination from one side than from the other, with at least one light a foot higher than the subject's head. Where but two Photofloods are used—one on each side—good modeling is secured by having one lamp about twice as far from the subject as the other. See sketch above.



An indoor photograph taken with the arrangement of Photofloods and camera shown at the left. With two bulbs at A, three feet from the subject, and one at B, six feet from the subject, an exposure of 1/25th of a second was given at opening $f/6.3$

Where lamps cannot be tipped for directing light on the subject, remove the shade. In such cases, some sort of reflector *back* of the lamps will throw more light forward. A white cardboard, a pillow case, or even a bright dishpan held directly behind the lights will help.

Be sure that lights, especially those unshaded, are far enough to the side



so that they do not reflect into the camera lens.

Complete all preliminaries with ordinary bulbs in lamps, then when ready, replace with Photofloods.

With focusing cameras, get the distance right. If, for example, you have focused for six feet be sure that the distance from the subject to the lens is exactly six feet. Better measure it.

When flood lamp bulbs are employed for general illumination for a picture of a room, it is best to use a medium sized lens opening such as $f/16$ or the second stop on single lens cameras to get objects at various distances sharp. An exposure from one to six seconds is needed when using super-sensitive panchromatic film—depending on distance included, number of lamps, character of reflectors, and color tone of the room. When using Photoflash, bright room lights very near the subject should not be on, as a secondary image might be recorded if the subject moves in the intervals just before and after the flash, while the shutter is open.

Reflectors, such as those mentioned above, may often be used to good advantage in many types of photography with artificial lighting. Large sheets of Bristol board, obtainable at art stores, serve as inexpensive reflectors, and often enable the photographer to direct a small amount of light to a dark part of the subject, thus "cutting" shadows or adding to the modeling effect. For permanent use, white cloth may be stretched on a frame, and a stand provided for holding the reflector in the desired position.

OUR POINT OF VIEW

Here America Lags. Time to Change

MOST persons who are familiar with science in general and radio in particular will recall the litigation which has been taking place for some years between Lee deForest and Edwin H. Armstrong, over the regenerative circuit in radio. The question was: Which of these two was its real inventor? During a decade or so previous to the latest court decision, which has been rendered by the United States Supreme Court, exactly 12 courts had handed down decisions in this famous case. Six of these decisions favored the deForest claims to priority of invention, while six others favored the Armstrong claims. Now the Supreme Court has declared that the inventor of the regenerative circuit was Lee deForest, and in denying a rehearing it has ended the case, since there is no higher tribunal than this one. The prize is, of course, the most valuable of all radio circuits, and the decision given awards a monopoly of its use and control. This, then, is how the law, through its mouthpiece the jurists, answers a vexed question.

The law is a very old, very well established and consolidated human institution. Today, however, there is a new estate in the world, science, a comparative upstart but widely acclaimed by all or nearly all, and recognized as the increasingly dominant influence of our age. Yet so youthful is science, relative to the other estates, that its prestige and position remain to be consolidated in a formal way, as a peer of the older traditions. Now the two have come to loggerheads in one instance. The radio decision that was acceptable to the law is unacceptable to science: Men of science whose work permits them to formulate an opinion are almost a unit in the belief that the discoverer of the regenerative circuit was not deForest but Armstrong. They feel that the Court was confused by the technicalities involved and, in short, did not fully comprehend them.

This brings to the front a question which has been in the back of many scientific heads for a long time. Is it fair to any court composed of members who have not had technical training to ask it to adjudicate questions on science which a lawyer's training does not necessarily fit him to understand? How can most men who have concentrated on law and jurisprudence as intensively as is implied by their reaching the Supreme bench also be expected to know all the ins and outs of science? Certainly no scientist does.

Now that science and industry have come to play so important a part in modern life, and will play an increasingly important part in the world as we march on into the real Age of Science which has just begun, the time has clearly come when the courts should have at their elbow some kind of outside technical aid when dealing with technical matters—the best aid science can offer, honest and disinterested. Abroad, this fact has been recognized, and court aides—technical men—form a legal adjunct to the courts in cases involving patents. Here America lags and should catch up.

Railroads Look Ahead

CONGRATULATIONS, *M-10001!* Congratulations, also, to those far-sighted officials of the Union Pacific and to those scientists and designers of this streamlined, Diesel-powered train marvel and of her equipment, who made possible her record-breaking trip from Los Angeles to New York in October. Better than by any amount of short-run testing or sensational publicity of the usual type, you have, by breaking all sprint and distance speed records, revealed a vision of the future to our wondering eyes; and that future looks good. It shows an aroused spirit of railroad progress, a determination to step forward into the vanguard with other leaders of the modern age.

Fifty-seven hours from Los Angeles to New York—3500 miles—against a 1906 record of 71 hours; two refuelings of oil at four cents a gallon; 1.6 gallons of oil per mile consumed by the Winton 900-horsepower, V-type Diesel engine; 83 dollars total fuel cost for pulling the six-car, 211-ton train—this is indeed a significant achievement. Why it has been called a "bold and promising experiment" is rather unintelligible; there was no uncertainty as to the result as that statement infers. This train is a scientifically grouped set of known factors, the performance of which was predicted with great accuracy by noted scientists. The "experiment" lies only in the question as to whether this train, and others like it that are to come, will bring back to the railroads the passenger traffic that has been taken from them by buses, airplanes, and private cars. We think so. We venture to predict an early revitalization of railroads and their accession again to a strong position in the national scheme, conditioned or delayed only by the necessity for discovering what to do with present rolling stock which represents a huge investment.

M-10001 has, indeed, shown the way toward railroad prosperity. Without deprecating what she has done, our comment is: Why not long ago? SCIENTIFIC AMERICAN has urged for many years—almost since the airplane first taught the public something of aerodynamics—that the railroads be up and doing, that they adopt streamlining, increase speeds, cut the weight of their trains, and with it all build again a prosperous transportation system to serve the country that it helped, more than any other one agency, to build. Action comes late, but not too late. The railroads will no doubt now recapture, slowly but surely, much of their lost business and with it their moribund prestige.

Movies for "Death Drivers"

THE scene is a New York City court room. Behind the vacated judge's chair is a motion picture screen. The shades are drawn, the lights dimmed. Motor-car drivers, arraigned on various charges, compose the "audience" at this unusual movie show. By no stretch of imagination are they there to be entertained. Rather, they are being subjected to a novel psychological experiment.

From the "talkie" equipment comes the smooth, even tones of an experienced announcer. He is describing fluently, but none the less grippingly, the horrors of disaster on the highway—horrors brought about by just those things that brought this movie audience to this court room. On the screen cars careen into view, crash head-on; the terrifying sounds of crumpling steel, splintering wood, human voices in agony, lend stark realism. A careless driver swerves from the road, crashes over a cliff. A passing car gets too close, sideswipes another, a human life is sacrificed. And the voice of the announcer goes on to drive home forcefully the much needed lessons.

Here, briefly, is an educational use for movies, which at the same time can contribute mightily to highway safety. Many motor-car drivers cannot be taught by ordinary methods. The much needed lessons must be pounded home through eyes and ears; talking movies can do the job effectively.

QUINTUPLETS, QUADRUPLETS

The five famous Dionne infants, about five days after their birth in Canada

DURING the last few months considerable popular interest has been aroused concerning human multiple births, through the extensive publicity accorded the remarkable Dionne quintuplets. Having made a specialty of the subject of twins and twinning for nearly a quarter of a century, the writer was quite anxious to see these quintuplets, but for some strange reason was denied the privilege by the doctor in charge. We went so far as to visit the village of Callander, Ontario, calling at the doctor's residence, only to find him away on a case and unavailable.

There is only one very remarkable thing about the Dionne quintuplets, namely, that at the date of writing they are all living and show promise of surviving at least the period of infancy. Quintuplet births are not very rare, some 30 cases having been recorded in medical literature, at least 20 of them probably authentic. There has been no previous case, however, in which all were alive at birth or survived the first few hours or days. Dr. Dafoe and his nurses are therefore to be congratulated on their remarkable success in overcoming the hazards incident to premature births and in rearing these five little infants through the first four months. The babies have now as good a chance as any children to grow up, for they have the very best of care, and no expense is spared to give them everything necessary for their welfare during the first two years of their lives. The Ontario government, in collaboration with the Canadian Red Cross Society, are official wards of the quintuplets and spend about 150 dollars per week on their care. A backwoods hospital has been erected near Callander especially for the infants, which will be in charge of Dr. Dafoe. We shall all watch with interest this striking experiment in infant welfare.

ONE other possibly unique feature of the Dionne quintuplets is that they appear to be identical, derived from a single fertilized ovum (life cell). Dr. Dafoe asserts that they are identical on the basis of his own studies. The fact that they are all of the same sex—female—and that they are remarkably similar in appearance, favors his statement, but much more crucial tests are necessary. It is our hope that at some future time we may be of service in helping to determine by means of our methods whether Dr. Dafoe's judgment is correct. The study of their finger prints, palm prints, and sole prints should go far toward determining whether or not they are derived from one, two, three, four or five ova.

A good deal has been written within recent months about the occurrence of plural births of higher than five individuals. Extravagant statements occur in the older, non-critical, literature to the effect that much larger numbers have appeared at one birth. In view of all the facts, it seems safe to say that sextuplets represent the limit of human multiple births, and that even such numbers are extremely rare.

As we have said, quintuplets have been recorded about 30 times, with the probability that at least 20 cases are authentic. Quadruplets, triplets, and twins are all comparatively common, but their relative frequencies differ greatly. Twin births occur once in about 88 births, though their frequencies vary in different countries, being apparently highest in Denmark. Curiously enough, the frequency of triplets is about one in every 88^2, or one in approximately 7700 births. Quadruplet frequencies are said to be about one quadruplet in every 88^3, or approximately one in about 6,000,000 births. The actual figures fit but roughly the neat progressive series of one in 88 for twins, one in 88^2 for triplets, and one in 88^3 for quadruplets. No one has any good theory as to why the frequencies should even approximate this progressive series. Some critics consider the progression 88, 88^2, and 88^3 as largely forced and not well supported by the actual data. Nevertheless this mysterious progression of decreasing frequencies with increasing numbers at a birth is rather generally recognized as valid and is known as Hellin's Law, after the discoverer of the alleged series. If Hellin's Law should be stretched to apply to quintuplets we might expect a set of quintuplets to be born once in about 500,000,000 births, which would not be much more than once in a human generation. The actual frequency appears to be somewhat greater than this, but even at that, quintuplets are sufficiently rare to be true curiosities. If the writer, a specialist in this field, should be denied a future opportunity to see the Dionne quintuplets while all are living, it would be a shame, for no other set is likely to be born in his lifetime in a region accessible to him.

Comparatively little scientific work has been done on quadruplets and triplets, although work on triplets has been quite active in recent years. We know at least that identical quadruplets and identical triplets occur, though the fraternal sets are far more frequent. Twins, on the other hand, have been the subject of very numerous investigations and have been highly valuable as materials for attacking numerous bio-

TRIPLETS, TWINS

By H. H. NEWMAN, Sc. D., Ph. D.
Professor of Zoology, University of Chicago

logical problems of some significance.

Twins are of two main sorts, identical and fraternal. Identical twins are the product of the division of an early embryo into two tissue masses, each of which is capable of developing into a whole new individual. Sometimes the division of the original embryo is incomplete, and the result is a pair of twins united by some more or less extensive fleshy and bony bridge. Thus Siamese twins, of which a number are at present surviving and earning a good living on the stage, represent one type of incompletely separated identical twins. Other types have two heads on one trunk, which is externally single, but double in many internal parts. Double monsters are not infrequently born, but, fortunately, few survive. True Siamese twins are less handicapped than others, but at best their lives must be very much hampered by their close union. Recently the newspapers have been enlivened by stories of the engagement of one of the Hilton Siamese twin sisters and her unsuccessful application for a license to marry, her twin sister not being a party to the contract. License bureau officials, sensing the anomalies of the situation, have refused to issue such a license both in New York and in Chicago. We suspect that the whole business may at least afford good professional publicity for the twins.

FRATERNAL twins are not strictly twins at all, but merely coincident births. They are the result of two ova freed and fertilized at the same time. The human species typically frees but one ovum in connection with each monthly period, and the occasional liberation of two ova is merely evidence of the inexactness of an otherwise nearly constant mechanism. Because fraternal twins start independently and have an origin no different from that prevailing among brothers and sisters, they may be both of the same sex or of opposite sexes. And the members of a pair are no more similar than are brothers and sisters, except that they are of the same age while brothers and sisters are usually a year or more apart.

The situation with regard to identical twins is quite different. The two members of a pair are always of the same sex and much more similar than are ordinary brothers and sisters. The reason for this is clear. Identical twins are derived from a single zygote (fertilized egg) and it is known that sex and many other characters are determined at the time of union of the ovum (female gamete) and the spermatozoon (male gamete). Any given zygote has at the time of its origin a unique and fixed hereditary potentiality, hence two or more individuals derived by division from a single zygote will have the same hereditary potentialities. This is why identical twins are always of the same sex in a pair, and have such a high degree of resemblance. Identical twins are, however, never completely identical, for several reasons. There may be slight or marked differences in the prenatal and postnatal environment that cause the same potentialities to express themselves somewhat differently in the two individuals. Again, since one twin is derived from the right half of a single embryo and the other from the left half, we might expect pairs of twins to differ as much as do right halves and left halves of single individuals. Thus it is quite common among identical twins for one to be right-handed, the other left-handed, and not unusual for one twin to have the crown whorl of the hair twisted clockwise and for the other twin to have a counterclockwise whorl. This type of mirror imaging involves many other parts of the body including palm and finger prints, tooth irregularities, and in extreme cases such as Siamese twins, even the heart, stomach and main blood vessels. So we may expect some identical twins to be as unlike as are sometimes the two halves of a single body. The most extreme differences between the components of a twin pair are, surprisingly enough, found in Siamese twins. In a few cases the two members have been so different in appearance as to resemble each other hardly at all.

THE chief scientific value of twins comes out of the fact that in identical twins we have two individuals with the same hereditary make-up. This gives us a chance to determine what effects may be produced in the development of individuals by differences in the environment. Thus we have determined for 50 pairs of identical twins reared together, how much they are alike and how much they differ on the average, with respect to all sorts of characters. We have determined their differences in intelligence (in their intelligence quotient, I.Q.), their differences in temperament and emotional reaction, their differences in height, weight, head size, dentition, and a score of other characters. All differences found are, on the average, relatively slight. The average differences in I.Q., for example, are hardly greater than those made by a single person on two attempts at the same test. Average differences in body height are not much greater than the differences found in a single person at different times of the day. Differences in body weight average only five pounds, a difference no greater than that found in single persons weighed at two periods a few days apart. In brief, the differences between identical twins reared together in the same environment are actually, on the average, hardly greater than those found in single persons at slightly different periods.

Now a group of identical twins reared together would make an ideal control

Quadruplets, possibly identical. This and the two succeeding illustrations by courtesy of the *Journal of Heredity*, organ of the American Genetic Assn.

Identical triplets. Triplets average a single set for each 7700 births

for a scientific experiment in which identical twins were separated in infancy and reared apart under various degrees of environmental difference, but how can the investigator manage to separate twins and rear them apart? Scientists could hardly expect parents to give up their twin babies for scientific experimentation and society would probably frown upon any such cold-blooded procedure. Fortunately, however, at least for our work, a good many pairs of identical twins are left orphaned in infancy and the twins are offered for adoption. Commonly the two are adopted by different families and are brought up sometimes far apart and under very different environmental conditions. There may be great differences in education, in social status, in physical surroundings, and in many other ways. In some cases one twin is reared as an only child, the other as a member of a considerable family of children. Our task has been to locate these separated twins, bring them to our laboratories and examine them in detail. In five years we have had the good fortune to secure 21 pairs (including two pairs examined by two other investigators). The amount of effort required to locate so many pairs of separated twins and to persuade them to come to Chicago for examination has been even greater than you might imagine, but the last ten cases were made much easier to get through the Century of Progress Fair. Many previously refractory cases long on our list were unable to resist the inducement of an all-expenses-paid visit to the Fair. So we have the Fair to thank for aid in attaining our goal of 21 cases.

NOW I think that anyone will admit that when we find significantly greater differences in twins reared apart than in those reared together the increased differences are the result of differences in the environment. Also when we find that in some characters, such as height and head size and shape, that those reared in different environments show no greater differences than those reared together in the same environment, we have a right to conclude that such characters are not appreciably influenced by existing differences in environment.

The detailed analyses of the effects of environmental differences upon the development of individual characters are as yet incomplete, but one may be permitted to say with but slight reservation that such characters as I.Q. and body weight are definitely influenced respectively by education and physical-health environmental differences, whereas such characters as stature, head shape, fingerprints, and so on, are little if at all influenced by post-natal environmental differences. One of the strange and unexpected findings derived from this study is that there appears to be no correlation between differences in social environment and the temperament-emotional differences found in separated identical twins. As to what the meaning of this strange result may be we have as yet no satisfactory theory.

MANY of our cases of identical twins reared apart have afforded facts of great human interest. There is even quite an element of romance in several of the cases. Consider the dramatic possibilities of such a case as this: A young man employed by a telephone company is startled one day by having a stranger slap him on the back and say "Hello Fred! How's tricks?" Since he was not Fred and did not know the one who accosted him, he made these facts known, but the stranger was hard to convince for, as he asserted, the Fred he knew was the exact image of our young man. It turned out subsequently that Fred was his twin brother who had been lost to him for over 25 years and about whom he knew nothing.

Another case was equally dramatic. A young lady taking a bus trip across Michigan happened to be seated by a Catholic sister who greeted her like an old friend. When our subject denied any previous acquaintance, the sister said that a girl exactly like our young lady had lived for years in her convent, and the way was opened up for bringing together these twin sisters who had never suspected the existence of each other. Their first meeting was a high point in their lives and they have been inseparable ever since, both working in the same building, one as a doctor's and the other as a dentist's assistant, and both consider that they have found their right niche in life. Several other cases are equally full of human interest, but space will not permit us to relate their stories.

Some of the environmental differences found in cases of separated twins have been very marked. In one case one twin had stopped her education at the end of the third grade while the other had completed her college education and was a high school teacher. In another case one twin married a poor man and had a hard and wearing life, while the other married a prosperous merchant and had lived in comparative luxury. In still another case one twin had led a thoroughly steady and respectable life while the other had spent a good deal of time in legal confinement. Such cases as these afford extremely valuable material for the study of the relative values of nature and nurture in determining human personalities. More cases of this sort are badly needed.

IN conclusion, it may be said that both heredity and environment are shown to be strongly effective in determining human characters. In some types of character heredity has much the greater influence in producing differences, in other types of character environmental differences have a profound effect. No general statement to the effect that heredity is more important than environment, or that environment is more important than heredity, has the slightest meaning. Both factors are essential for the development of any character. Some characters are not affected by existing differences in environment, others are profoundly affected by such differences. This is as much as can be said by way of generalization. More specific statements can be made only for particular characters and under special conditions.

The old problem of nature versus nurture turns out to be immensely complicated, and will not be fully solved for a long time to come. Identical twins reared apart, however, give us the best clue to an ultimate solution of an age-old problem.

Identical twins. Twins arrive once in 88 births. This is an average

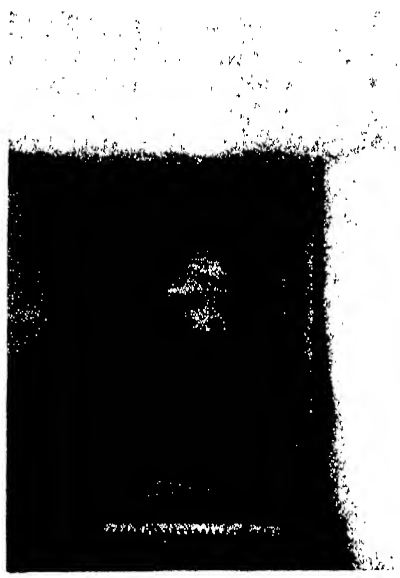
GUARDING EGYPT'S TOMBS

Protective Portcullises Broken Open . . . Trick Sliding Doors Failed . . . Granite Slabs Circumnavigated

IN ancient Egypt there was little to steal except in palaces and tombs. Even at that there were racketeers, public enemies, burglars, and small-fry chiselers to be considered. The precautions which the ancient architects employed were practical, as far as they went, but their brains were pitted against the skill of the members of Egypt's best underworld.

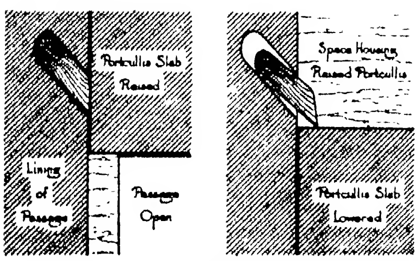
It is due to the last two years' work of the Metropolitan Museum of Art's Egyptian Expedition that it is possible to show how these ancient gangsters were combated by the temple and tomb builders.

In the case of one tomb at the small pyramid at Lisht where Se'n-Wosret-'Ankh was *once* buried, there was a sloping passage down which the remains were lowered and a chimney which was probably an escape shaft to be used by the workers after the sloping passage was sealed. There were four portcullis



Arrow points to sliding stone slab propped up by the tomb plunderers

Sliding door of stone (arrow) rested on perishable wooden rollers

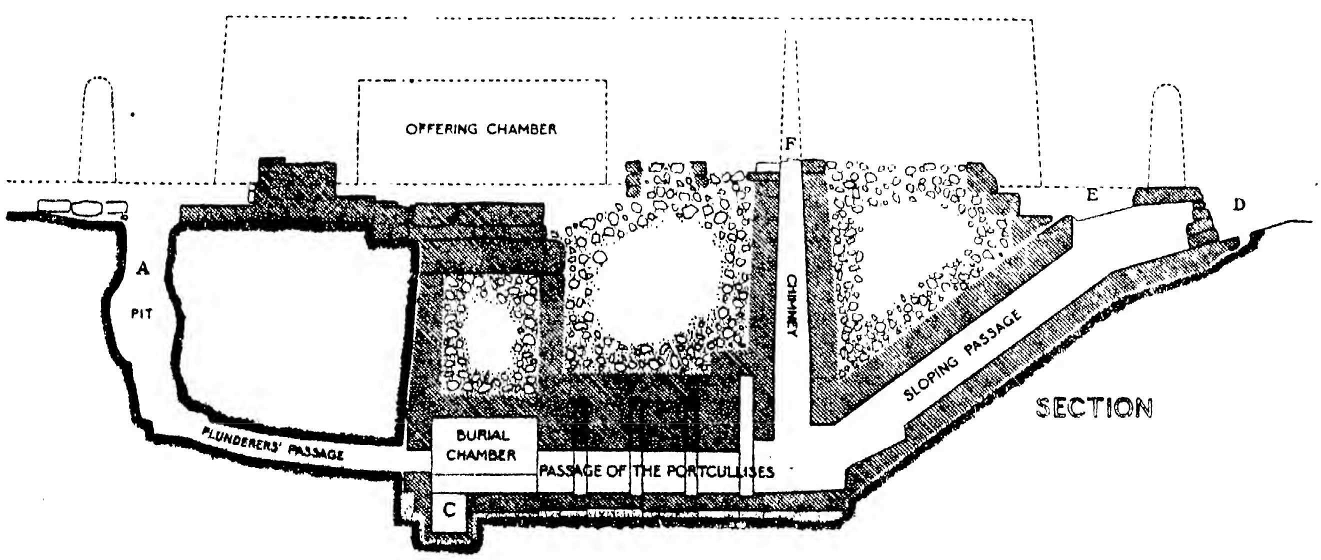


An ingenious method of using pins to retain lowered portcullis slabs

recesses (see drawing below) to receive stone slabs which raised and fell vertically. When once closed, pins dropped into place as shown in the other drawing, thus preventing would-be robbers from raising the slab. Eventually, however, plunderers attacked the tomb from another angle and dug another passageway to the burial chamber, as is also shown in the drawing below.

Near the north side of the pyramid were found the remains of a chapel. The inclined entrance to the tomb had been plugged with granite, but to no avail, as plunderers had dug around the stone and sacked the tomb.

In the neighborhood was discovered another tomb that had been robbed. Examination disclosed a pair of limestone sliding doors which rested on wooden skids. It may be presumed that the designer of the tomb expected the wood to rot and thus leave the doors in an immovable position. Clever plunderers, however, smashed one of the doors, and when the Expedition found the spot they had to press into service a five-ton jack to move the other.



A well protected tomb where plunderers found that the easiest method of ingress was not that of the builder

HOW BIG IS THE

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington
Retiring President of the American Association for the Advancement of Science

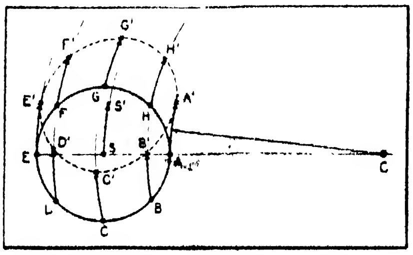
EVER since Herschel's memorable star counts more than a hundred years ago it has been recognized that the galaxy, which appears to our eyes as a band of diffuse light encircling the heavens, is really a vast flattened assemblage of stars shaped roughly like a thin watch or a convex lens. For a long time it was supposed that the sun was not far from the middle, since the numbers of stars visible to the naked eye or even with a small telescope are about the same for equal areas of sky in all parts of the circle. But within the present century it has been discovered that we are actually far out of center.

Shapley's studies of the globular star clusters, which gave the first fair idea of the real expanse of our stellar system, showed clearly that the center of their distribution is far away, in the direction of the constellation Sagittarius. About the same time Barnard's recognition of the dark nebulae, visible only because they hide the stars behind them, led to the recognition that the great dark band which splits the Milky Way in two from Cygnus to the Southern Cross arises from obscuration by an enormous succession of dark clouds. Could these be swept away the bright region in the southern summer skies would be far bigger and brighter, and no one could doubt from a mere glance at the sky which way to find the center of our great starry system.

BUT why should the galaxy be flat? The natural form of any body at rest is spherical, and this deduction from theory is confirmed by observation of bodies all the way from raindrops to globular clusters. There is only one known force which can flatten out a mass isolated in space and keep it so, and this is the centrifugal force of rotation. The planets, for which the centrifugal force is but a small fraction of the gravitational attraction, are but moderately spheroidal. The galaxy is greatly flattened, hence the centrifugal force due to its rotation must nearly equal its attraction.

The dynamics of a great rotating swarm of particles have been worked out by Lindblad and by Oort. In the case which concerns us there is a great, moderately flattened central swarm surrounded by a thin and almost discoidal sheet of particles moving in nearly circular orbits — something very like a spiral nebula, except that the outer parts may be spread out into a disk rather than concentrated into arms. In this outer region the particles, which in the present case are stars, are moving in nearly circular orbits about the central condensation. There are, of course, small differences in the speed and direction of motion of individual stars.

When we study the motions of the nearest stars, hoping to find from them the "sun's motions in space," we are dealing almost exclusively with bodies moving in these nearly circular orbits. The average of these stars, to which standard the "solar motion" is referred, represents motions in a circle about the galactic center. They may all be moving together very rapidly—and, indeed, they are.



Motion of stars about the center of the galaxy (all in plane of paper)

There are several evidences of this. In the first place the stars which move slowly (relative to the above standard) seem to move nearly at random, but the fast-moving stars, of which dozens are known, have motions which, though far from parallel, are practically all directed toward one half of the celestial sphere.

These stars, according to Oort, are members of a "field" of bodies which, though moving about the galactic center, have orbits of high eccentricity and inclination. As a whole these form a thin, scattered cloud extending far on both sides of the denser disk. Those in our general vicinity are moving slower on the average than those which have circular orbits. So they are left behind and appear to drop toward the rear.

Still more definite evidence comes from observations of the radial motions of distant objects which lie on the outskirts of our galactic system, like the globular clusters, or quite outside it like the globular nebulae. Strömberg finds that, compared with the clusters, our "local" system of reference is moving toward a point in the constellation Cygnus at a velocity of 272 kilometers a second. The nebulae are more troublesome to handle, on account of their own very rapid motions, but Hubble, allowing for these, finds a speed of 280 kilometers a second in the same direction.

THESE data alone are enough to convince us that the galaxy is actually in rotation; but further tests may be applied. With motion governed mainly by the attraction of the central mass, the stars nearer the center, which have smaller orbits, will move faster in them, as the planets do; those further out will have smaller velocities. This will have curious results, as is illustrated in the diagram. Suppose that a star S is surrounded by eight others A, B, C, D, E, F, G, H, all moving in circles about the center C. In due time S will move to S', A to A', and so on. The eight will still form a ring about the one, but this will be no longer circular but oval. The stars H and D will be in nearly the same direction from S as before, but farther away; while B and F will be nearer. C and G will change their distance very little, but will shift in direction in the same sense as the real rotation, while A and E, also with unchanged distance, will swing around S in the opposite sense but more slowly.

Stars originally lying on a circle were chosen in order to make a simpler diagram, but the same effects will appear for any others. Those in the direction of the center and opposite to it, as seen from S, will drift backward, and those at right angles to the center forward; while stars near the middle of the respective quadrants will approach S or recede from it. The linear motion in all cases turns out to be proportional to the distance from S (to the first approximation). The angular rates of drifts are therefore independent of this distance. All this holds for stars moving in strictly circular orbits. Actually a smaller random motion is superposed, so that the effects here illustrated may be obscured for individual stars but come out in the mean for large numbers. The sun,

MILKY WAY?

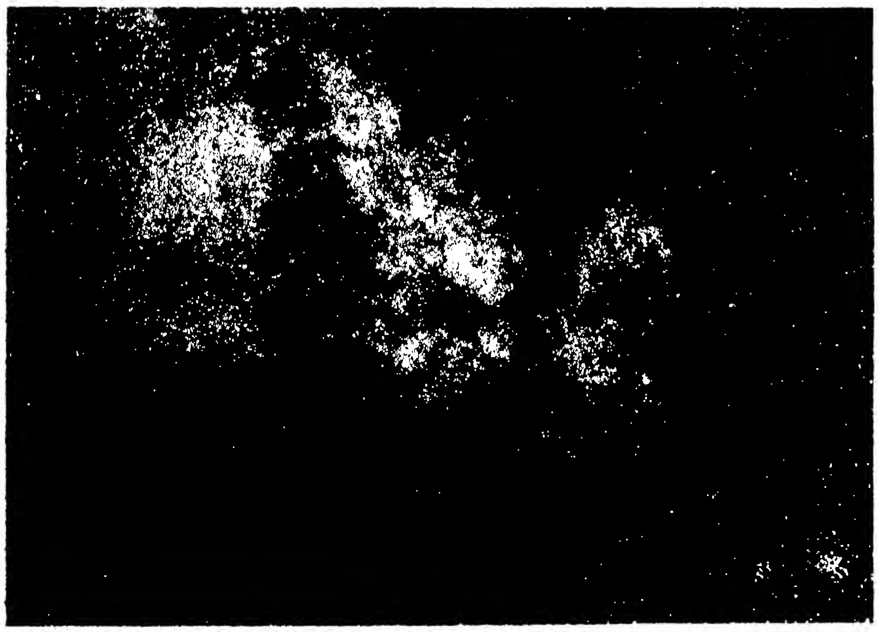
too, is not moving just at the standard rate like our imaginary *S*, and this causes another set of star drifts affecting the average motions. These, however, can easily be separated from the effects of galactic rotation, for the former have only one maximum and minimum value for stars around the whole circle, while the latter, as is obvious from our diagram, have two.

Many investigators during the last ten years have sought for these phenomena and they have found them in almost every group of stars that they have investigated. Either proper motions or radial velocities may be used, but the latter have some advantages. The directional changes due to galactic rotation are very slow, and are likely to be concealed by the random motion of individual stars except for the average of very large numbers. The effects on radial velocity increase with distance, and for remote groups of stars they may become relatively large and even quite conspicuous.

A comprehensive discussion has recently been made by Dr. J. S. Plaskett, the veteran director of the Dominion Observatory at Victoria, and Dr. J. A. Pearce, based on stars of spectral classes *O* and *B*, "the most luminous stars in the sky and hence the most distant that can be adequately spectroscopically observed." A ten-year program of observation at Victoria, supplemented by observations in the southern hemisphere, by the Lick Observatory station, gave the radial velocities of some 850 stars—enough to get good average values for many sub-groups. The rotational effect is very clearly shown. It is greater for the fainter stars than the brighter ones—as it ought to be, since the former look faint largely because they are farther away—and for the same reason greater for the hottest stars, which are the brightest and hence can be seen at the greatest distances. The direction of the center comes out in 324 degrees galactic longitude; that is, toward Sagittarius, and only three degrees different from that found by Shapley from the globular clusters.

The proper motions of the stars also showed the predicted effects. After allowing for the solar motion it was found that the forward drift of the stars at the points *C* and *G* was eight times as great as the backward motion at *A* or *E*. For stars moving in empty space about a distant cluster the motion at *A* would be half that at *C*. But the discrepancy is not in the least alarming, for the space in which the stars actually move is by no means empty but is occupied by the great flattened swarm. For stars with larger and larger orbits the attraction of an ever-increasing portion of this is added to that of the central mass. In consequence, the orbital velocity falls off much more slowly with increasing central distance than is illustrated in the figure. The observed conditions indicate that in the sun's vicinity three quarters of the whole attraction is due to the central condensation, and the rest to the outlying portions.

It appears also that the period of rotation about the center in an orbit passing near the sun is 224 million years. With the velocity of 275 kilometers per second this makes the distance to the center 10,000 parsecs, or 32,000 light-years. It is probable that the sun is about two thirds of the way from the center to the edge, which makes the diameter of the galaxy 30,000 parsecs, or roughly 100,000 light-years. This is much bigger than the average spiral nebula, but hardly more extensive than the outer fringes of the Andromeda nebula which have recently been detected. The mass of the system follows from its attractions at a known distance, and comes out 160 billion times that of the sun (1.6×10^{11}). The known stars will account for only a fraction of this. But the obscuring matter scattered through the galaxy, though very tenuous, must have a very great aggregate amount. It may be roughly assumed that it occupies a layer 1000 parsecs thick and 30,000 in diameter. Its density can be little more than guessed at. Eddington suggests 10^{-23} grams per cubic centimeter, which amounts to one ounce in 700 million cubic miles. Even with this incredibly small density the supposed layer would have a mass 100 billion times the sun's and would account for the discrepancy.



Star clouds and obscuring matter in Sagittarius. Shapley places the center of the galaxy behind impenetrable cosmic clouds of meteoric dust where the constellations Scorpio, Ophiuchus, and Sagittarius corner together. This is in the part of the Milky Way which has the appearance of dividing into two branches, a mere appearance which is due to a long obscuring cloud of dark matter of this kind. Some of these clouds show in the photograph, especially toward the right, and it is near here that the galactic center is believed to lie. Were it not for this "unhappy caprice" in the arrangement of the material of our world we should see the galactic center on summer evenings, doubtless as a heavy concentration of Milky Way stuff (stars). The obscuring clouds are much nearer to us than the galactic center, but the clouds or swarms of stars which show in the photograph are at practically the same distance as the obscured galactic center. From the "Photographic Atlas of Selected Regions of the Milky Way," by Edward Emerson Barnard. Taken at Mount Wilson, with 10-inch lens, *f*/5, exposure four hours. "These star clouds," says Barnard in the same atlas, "are the most magnificent of the galactic clouds visible from this latitude." In the reproduction they show to poorer advantage than on the original photograph, because the dark obscuring clouds around them, mainly on the right, do not have the blackness of the original. Note cluster in lower right hand corner of cut

A New Deal For Mice

Why Mice are Used in Research on Human Diseases

By C. C. LITTLE, Sc.D.

Head of the Roscoe B. Jackson Memorial Laboratory for Cancer Research

DO you like mice? Of course you don't. "Useless vermin," "disgusting little beasts," or something worse is what you are likely to think as you physically or mentally climb a convenient chair. That is the inherent right of all women and some men. Granted, however, that you are all figuratively placed safely above "floor level" where the terrified little brown creature that rushed for shelter as you approached will not disturb you, I want to appear as attorney for the defense and try to show you a little of what the domesticated relatives of that same mouse are doing for humanity. It is at least an even bet that you will descend from your place of refuge with deep and lasting interest in the little rodents which, when tame, are not nearly as "cowerin" and "timrous" as the immortal Burns has painted them.

The particular service to humanity about which I am going to tell you is research in the nature and cause of cancer. There are many other phases of medical research which might have been chosen, such as pneumonia and yellow fever, in which mice are the troops which literally by tens of thousands occupy posts on the firing line of investigation. Their reactions to the microorganisms that cause infectious disease are used as indications of its type and virulence. I have picked cancer, however, because mice are afflicted with it very much as are we ourselves. It occurs in them naturally as it does in humans. If untreated, it kills them as it does us.

IF we had to depend on wild mice for our studies it would not be very convenient. Such, however, is far from being the actual situation. Mice have been domesticated and kept as pets since long before the beginning of the Christian era. There are more color varieties of mice than there are of all breeds of domesticated dogs. There are white mice, piebald mice, as spotted as any pinto pony, yellow mice of various shades, from pale cream to deep orange red; there are mice that exactly resemble a maltese cat, and in addition many shades of fawn, tan, brown, and gray. In Great Britain, mouse fanciers may be numbered by the hundreds. Exhibitions are held and prizes are awarded according to standards such as those that govern thoroughbred poultry, horses, or other livestock.

The idea that mice may be thoroughbreds has a certain amusing side. Yet even to those of us who painstakingly and with some pride and expense have traced—or believe that we have—our ancestry some 40 generations back to William the Conqueror, the mouse need not bow his furry head. In the laboratory

Operation on a mouse under ether

are thousands of mice whose exact pedigree is known and recorded for more than twice that number of generations.

You may naturally ask "why bother?" "What earthly good does it do to have pedigreed mice?" The answer is full of surprises. In it there will be elements of modern scientific advances as yet unappreciated by the non-scientific reader—but of great interest to him none the less.

In the first place cancer in mice occurs in certain lines of descent, or strains, and not in others. This fact was first noted at the end of the first decade of this century. Since that time additional studies have shown that not only is the amount of cancer formed characteristic of the strain, but also the type and location of cancer tends to be the same within members of an inbred strain of mice.

Cancer may, under certain conditions, be successfully transplanted from mouse to mouse but not from mouse to rat or *vice versa*, or between mice and men. The study of the reaction of various inbred strains of mice to implants of the same mouse cancer, or of the reaction of a single strain of mice to implants of several different types of mouse cancer, is both interesting and important. Not all mice successfully grow transplants of all kinds of mouse cancer. This gives us material with which to gain information concerning the nature of the differences that exist.

THE age of the individual mouse is an important factor in determining the way in which it is going to react to bits of mouse cancer placed beneath its skin. In a certain strain all mice which are young adults may eliminate such implants of cancer tissue promptly and effectively within a week. There is not even temporary growth of the introduced cancer tissue. Animals of the same strain, when implanted with cancer when they were from two to twenty days old, show more tolerance towards the implants. There is a certain amount of growth of the cancer followed, however, as the mice grow older, by its regression and disappearance. If we describe the typical reaction of young adults of the strain as "negative" we must conclude that the very young animals of the strain have not yet acquired their racial characteristics in full degree. When very old mice of the same strain are inoculated, they too allow temporary or even permanent persistence of some of the bits of implanted cancer. These old animals have begun to lose the "negative" response which characterizes animals of this strain in their prime.

The bearing of these facts on our ideas of biological individuality is obvious. As humans we lay great stress on that term. We prize individuality and bitterly resent any intimation that we are in danger of losing it. Yet it is clear that, from a physical point of view, we acquire individuality gradually and after keeping it for a time, begin to lose it through a process of disintegration. It is perhaps much more than a striking coincidence that the commonest ages of cancer incidence are

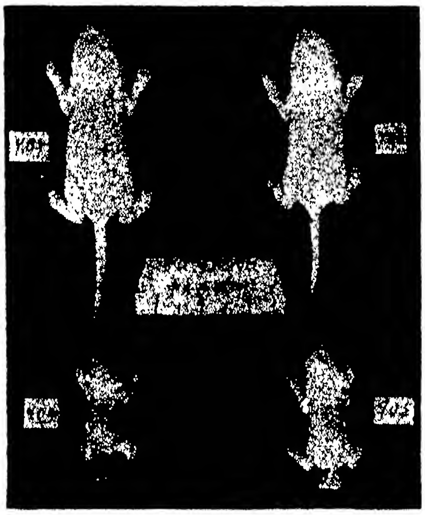
those when either generally or in some particular organ the process of disintegration has begun. This fact opens one of the fascinating lines of advance on the cancer problem which biology has given us. It may in the not too distant future lead to important results and conclusions.

Our present social customs serve to confuse and complicate the collection of pedigrees in humans. Outbreeding rather than inbreeding is the established procedure. This makes it especially difficult to determine in human material the course of any inherited character. We are fairly well "scrambled" biologically and the sorting out process necessary to trace inheritance is in many cases scarcely worth the effort. This however is not the case in mice.

SOME years ago the principle was discovered that close inbreeding makes for great uniformity. In order to obtain this uniformity, however, the process has to involve the mating of brother and sister or of parent and offspring. Inbreeding, as such, creates nothing new. It merely brings out consistently and with increasing uniformity the various characteristics which are being inherited. After 12 or more generations of this procedure the animals within a single inbred line resemble one another extremely closely. The characters which are inherited in the strain are fixed and, to a high degree, predictable.

As a result of this process, strains of mice have been built up in which cancer of the breast appears in from 80 to 100 percent of the female animals. Other strains have been obtained where no cancer of the breast has occurred in more than 30,000 animals comprising over 40 successive inbred generations. In mice, therefore, it is clear that the tendency to form cancer of the breast depends largely on constitutional factors which are inherited. A high cancer stock can be used day in and day out as a natural source of cancer material for study and research. Because it is known in advance what the stock is going to do the research worker can be on the look-out for characteristics of the earliest stages of cancer. This is an advantage which is not possessed by any group of human material. It is another great contribution which mice, after over 20 years of controlled breeding, have given us, in our fight against cancer.

Uniformity of type produced by long-continued inbreeding gives material which, for the first time, allows the biologist to approach experimental work with something resembling accuracy. This means a great deal to the research worker. The chemist, for example, could get nowhere in his attempts to analyze unknown substances if he could not turn to his laboratory shelves for the already analyzed materials which—as known reagents—are available to him. In a somewhat analogous way, it is useless to expect the biologist to be able to analyze unknown living material without having, at his disposal, strains of relatively homogeneous animals which he can use as "known" values in that work. The building of such strains is never particularly spectacular or exciting. It is, however, an essential foundation to further progress of any sort. Now that biologists and research workers in experimental medicine have such material where they can obtain and utilize it we may expect more accurate results capable of repetition at will.



Two normal and two short-tailed young mice about ten days of age. The short-tailed variety of mouse was first discovered in Germany

An interesting example of how effective known strains of mice may be in analysis is the following: For decades, British investigators have inoculated mice of unknown ancestry with bits of a certain mouse cancer. In some of the animals the implants grew, while in others they did not. A long series of groups of perhaps 50 mice each were used. The variation which occurred in the successive groups gave an appearance of fluctuation in the virulence of the cancer. This explanation was adopted by those who did the experimental work. Recently this experiment has been repeated in this country, using, however, mice of known strains. It was found that *all* the mice of some strains grew the inoculated cancer while *none* of other strains did so. By mixing the animals of the two sorts of strains in various proportions it was possible to repeat exactly the earlier results obtained by the British investigators and to predict in advance what those results would be. This was done with less than three tenths of one percent inaccuracy. Thus it was found that the nature of the strain of mice used, and *not* fluctuation of virulence in the cancer itself, was the important factor which, because of lack of controlled material, caused the British workers to misinterpret their results. Experimental science is full of friendly international competition of this sort. It is a game quite as exciting to those who participate in it as are the Walker Cup matches to golfers or the Davis Cup contests to tennis enthusiasts.

Another advantage which mice provide to research is the rate at which they grow old. To understand this point we must realize that, in humans, the vast majority of cancers occurs in middle-aged or older individuals. It is obviously impossible for a research worker to observe many generations of human beings because he grows old too quickly. Mice of a year old are roughly comparable to humans of 40. They thus reach, at an obligingly rapid rate, the ages at which cancer is most prevalent. This is an immense help in research. It makes possible the observation, by a single investigator, of scores of successive generations of cancerous individuals.

AGAIN, humans have a disappointingly small number of children. Not so with mice. There is, to be sure, a record of one woman who competed favorably in this respect with a mouse in that, by abundant production of twins, triplets and quadruplets, she gave birth to more than 40 children. This total is common among mice. Even in the days of polygamy a man might well feel proud if his children totaled a hundred. To a gentleman mouse a grand total of 400 sons and daughters is not in any sense an impossibility.

Nature has made, in mice, its most remarkable reproductive machine among mammals. The first litter of young usually appears when the female is from 50 to 80 days of age. The female mates again at once and is thus carrying her second litter while nursing the first. Young mice develop for a period of from 18 to 21 days in the body of the mother and can safely be weaned at approximately the same period after birth. Many stocks of mice average from six to eight young per litter. Exceptional litters may reach 14 young.

At birth the young are pink and naked. They weigh about one gram each. Yet in this tiny bit of living material is represented each of the organs and tissues which we ourselves possess. Successful surgical operations under anesthetics can be performed on mice as young as one day old. Their skin at that age, however, is so tender that even the finest surgical silk, unravelled and used as separate strands, tears out. For this reason incisions are closed by a hair-like strand of collodion drawn across the wound by a very fine camel's-hair brush. On its return from the operating table the young one is apt to be un-

welcome to the mother mouse. She may desert or even kill it—recognizing undoubtedly the foreign odors. To prevent this, it sometimes suffices to block the mother's nostrils with Vaseline. The removal of this so occupies her attention that by the time it is accomplished the young mouse has resumed the smell of the nest and is again received into the bosom of the family. Ordinary handling of young mice is, at once, followed by their careful washing on the part of their parent. It would seem that the odor which we impart is quite as unpleasant to the mouse as theirs is to us. This instance of "turn about is fair play" serves to satisfy—partially at least —our senses of humor and of justice.

THE cancers formed by mice differ in some minor points but not in their chief characteristics from those of humans. They begin as local areas of insurgent and uncontrolled growth. It is this extreme naturalness of cancer and its very apparent independence from micro-organisms that make its early detection a matter of the greatest difficulty. Since it has clearly been shown that, in humans, the chances of successful treatment increase directly with the recognition of cancer in its earlier stages, it follows that the opportunity of studying its early occurrence in thousands of mice is an important one.

The term "local insurgent growth" is worthy of further attention. We are all familiar with the results of normal growth. Everyone of us has experienced them. Each of us started as a microscopic bit of living material called a fertilized egg-cell. In the nine months of our life before birth we progressed almost miraculously to an organized typical human baby ready for birth. We had grown from the fertilized egg-cell to many thousands of times our original size. During our first year of life after birth we still grew rapidly. At best, however, we probably did not grow to more than five times our weight at birth. The next and each subsequent year we increased in actual size by growth—but did so at a steadily decreasing rate. This process went on until we reached adult size. We then stopped growing.

In us, however, there remained a potentiality for further growth. Ordinarily we used that ability simply to repair and to replace worn out tissues. At times, however, locally we may have formed a wart, mole or wen which is a center of growth—more rapid than that shown by surrounding tissues. These growths are, in a way, distant cousins of cancer, in that they represent local areas in which central control of bodily growth has been lost. Whereas, however, growths of the type listed do not invade surrounding or adjoining tissues and organs, and therefore cause little or no trouble, cancer is not so innocent.

Starting with no more visible signs of its presence than do the other growths, cancer grows rapidly, invades the surrounding—or even remote—tissues and causes an upset in the general orderly behavior of the body. Cancer often demands and receives preference in blood and food supply as compared with the normal tissues. At times, it shows an amazing rate of growth, resembling that of very young tissue. It may even outgrow its food supply and cause trouble by the formation of areas of death and degeneration of its own substance.

A view of the under surface of a male mouse with a cancer of the breast. This mouse was operated on when it was five weeks old. Both male sex glands were removed and a female sex gland from a sister animal was placed under the skin. About 16 months later the mouse was observed to have a cancer of the breast. Normal males do not do this once in a thousand times

It should be clear to all that an enemy of that type is a foeman worthy of our best and most skilful opposition. No fortuitous or fly-by-night campaign will win the fight against cancer. Slow, patient, well-organized experimentation will be needed. Even then, no one in his right mind has any illusions concerning the probable magnitude and importance of his potential contributions to the cancer problem. He is prepared for disappointment and, by being so, need never admit lasting defeat.

A question, frequently asked, is by what right we believe that work on mice is transferable to human beings. The answer is an interesting one. There are many points of close resemblance in the two types. Both types, for example, form two types of male sex-cells which are the most important single influence in determining whether an individual young mouse or a baby shall become a male or a female. In a single nationality of mankind the ratio of the sexes at birth is approximately 103 males to every 100 females. Practically the same ratio is found in mice. If, in humans, the sex of children of parents of different nationalities is computed the ratio is found to be about 120 males to 100 females. If two unrelated inbred strains of mice are crossed a similar increase in males is observed.

Cancer of the breast in humans is confined to the female sex in practically 99 out of a 100 cases. Exactly the same fact holds true in mice.

MICE frequently die of inflammation of the lungs or of the kidneys, just as humans do. The parallel between mice and men is so striking that there is every reason to believe that mice will serve their useful purpose in contributing to our knowledge of human ailments just as rats have helped our knowledge of the vitamins, rabbits have aided in combating syphilis, and guinea pigs have increased our information concerning many human ailments.

Mice have already proved to be of great practical value in the Ascheim-Zondek test to determine human pregnancy.

With these and other facts in mind, and with the mental picture of the hundreds of thousands of these little animals which year after year have done their part in increasing our chances of survival, it seems not too much to ask that a new place in human appreciation be given them.

A visit some day to one of the mouse laboratory "cities," with its cleanliness, orderly arrangement, and activity, will do much to convince those in whom doubt remains. The lives of these mice are scarcely more confined than our own. They live in warmth and plenty. When need for surgical aid occurs, their treatment is asceptic and humane. No marauding cat disturbs their slumbers, no erratic taxi drivers imperil their existence. We humans cannot claim as much. Tame, bright-eyed and trustful, they seem to have become an integral part of man's helpers, instead of wasteful and undesirable vermin.

Under those circumstances, perhaps mankind will accept and develop his relationships with mice in a different spirit. They have earned their right to respect, and perhaps some day by being partners in our fight against disease, will obtain our everlasting gratitude.

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Before submerging various areas in the Tennessee Valley with dams, the TVA has thoughtfully carried out a scientific archeological survey of them. An account of these excavations will be published soon.—The Editor.

REVOLUTION Among the LUBRICANTS

Low Grade Crudes Give High Grade Motor Oils... Propane Used in Refining . . . Process Removes All Wax

By ANDREW R. BOONE

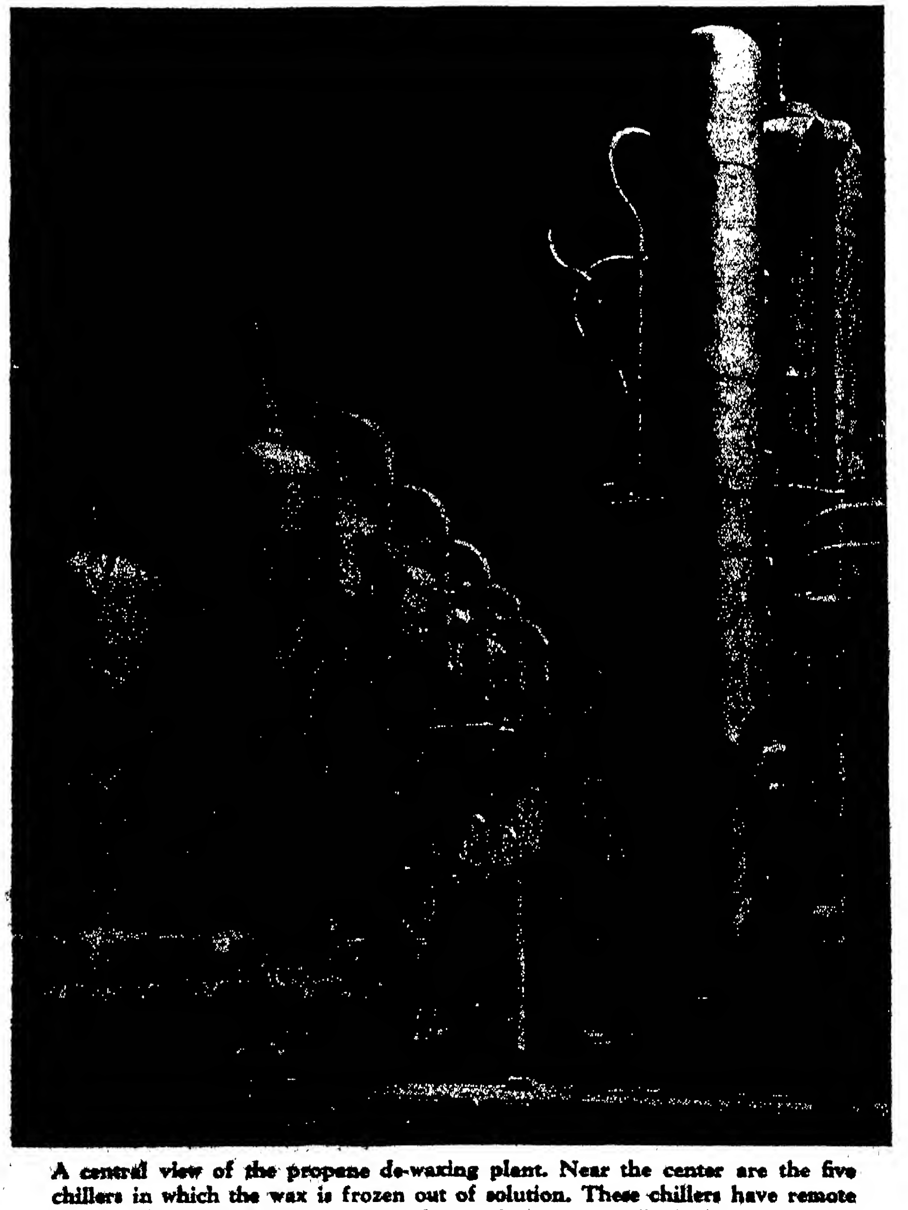
REVOLUTION born of the test tube stalks among the petroleum refineries. Domination of Pennsylvania oils is threatened. Too-great national popularity has raised a contender to their superiority. California crude occupies the challenger's corner. Low-grade crudes now supply values of lubrication thought impossible of production a year or so ago. By developing a solvent refining process using propane, western manufacturers promise rich development of California fields producing wax-bearing crudes.

The development is of great importance economically, of much interest scientifically. For years Pennsylvania oils have been the "sterling" among lubricants. But something has been happening in the design of motor-car engines during the last nine years. There has been a steady increase in the average horsepower of passenger-car engines, resulting in increased loads on bearings, and increased piston speeds, demanding oils of great stability, low susceptibility to oxidation, and a flat temperature-viscosity curve, capable of withstanding excessive pressures.

Pennsylvania oils came closer to meeting these needs than western oils. The public in the west apparently recognized this superiority, for, in California, Oregon, and Washington, where 2,800,000 automobiles, farm power units, industrial and ocean-going engines consume 80,000,000 gallons of motor oil annually, sales of higher-priced Pennsylvania oils climbed last year while westerns dropped in volume. Thirteen years ago, 85 percent of the oil sold on the Pacific Coast was manufactured from western crudes; last year—55 percent.

Western producers and marketers faced a problem close to their pocket-books. The challenge could not be ignored. Several companies set about to develop a refining process that would isolate the desirable paraffin-base constituents and reject unwanted materials.

With this as the goal, a close study of California crudes was begun by the Union Oil Company, of California, and it was found that the wax-bearing crudes being produced in such fields as Santa Fé Springs, Kettleman Hills, and El-wood, contained a higher percentage of the paraffin-base constituents than the wax-free San Joaquin Valley crudes, from which all Western motor-oil manufacturers had previously refined their oils. The ratio was about three to one. Experimentation proved further that if a paraffin-base oil were to be refined from California crudes it would be necessary to use the wax-bearing crudes in order to secure a yield economically feasible. This brought up the problem of de-waxing. Eastern manufacturers had found this an expensive operation



A central view of the propane de-waxing plant. Near the center are the five chillers in which the wax is frozen out of solution. These chillers have remote controlled operating and pressure valves and also remote liquid level indicators

Dr. Ulric B. Bray, left, and C. E. Swift, demonstrating the precipitation with liquid propane of asphalt from lubricating stock

and one that was a constant source of trouble. In order to simplify this operation, if possible, experiments were conducted in various phases of de-waxing. From these and other experiments have come many patents, pooled by Union, Standard Oil Company (Indiana), and Standard of New Jersey.

C. E. Swift and Dr. Ulric B. Bray, a young Georgian who joined the Union Oil research department in 1928 and who formerly was a research fellow at the California Institute of Technology, undertook the solution of the de-waxing problem in the company's Los Angeles laboratory.

It was the discovery that propane could be used as a de-waxing agent that made possible the production of this new type of oil from California crudes. During his experiments with propane, Dr. Bray came upon the discovery that under pressure most petroleum fractions, except asphalt, were soluble in propane, and that when lubricating-oil-bearing crudes were treated with propane the asphalt settled out in semi-solid form. Since by releasing the pressure of the container holding the solution of oil and propane, a sub-zero temperature is created, the wax previously held in solution is literally frozen out of the oil and can be entirely removed by passing the solution through a pressure filter.

Thus, in what amounts to a comparatively simple refining operation, it is possible to remove two troublesome materials and prepare the way for the final treatment of the asphalt- and wax-free oil. The unstable materials and low-grade oils, many of which have not previously been removed even from our most expensive lubricants, were soluble in various solvents, whereas the high-grade oils, or those of the paraffin-base constituents, were not soluble, the latter being drawn off in the form of a raffinate consisting only of desirable oil, and the other as an extract containing all of the undesirable materials.

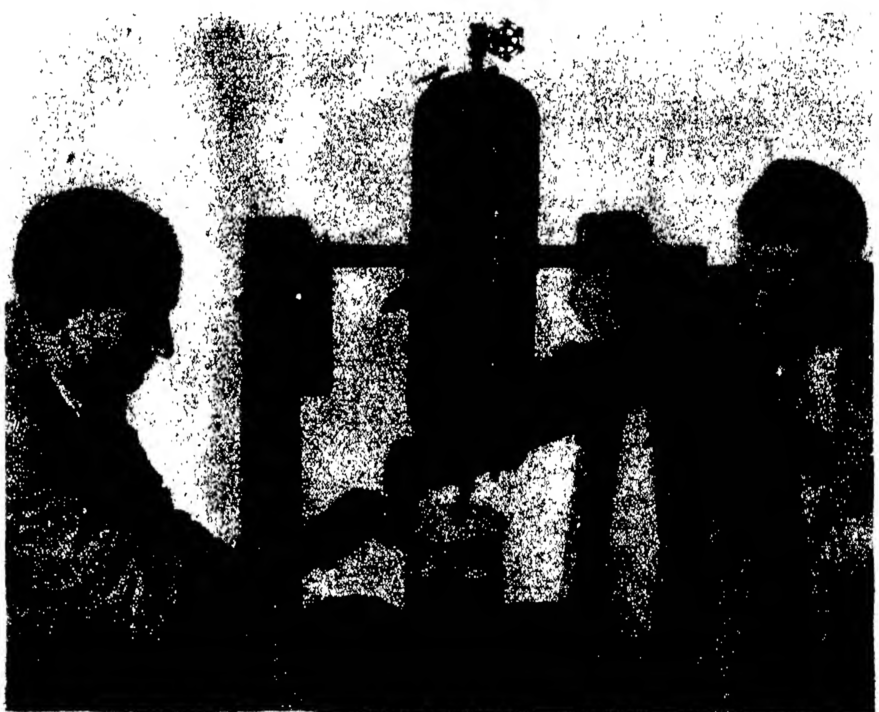
Petroleum chemists have known for some time that western, as well as eastern, crudes contained a percentage of paraffin-base oils. However, where they are present in the greatest quantity, they are accompanied by the troublesome wax. The removal of this wax by old refining methods is costly. The result has been that, until the development of the propane solvent process, western refiners have been restricting their production of motor-oils to so-called asphalt crudes containing virtually no wax and but a very small percentage of the paraffin-base constituents, which tests show form the most stable of motor oils.

By the development of the propane solvent process, it is possible for the refiners to revamp their entire motor-oil production program and turn to several of the large California fields producing wax-bearing crudes, which were formerly almost ignored in the production of motor oils. From these can be obtained a sufficient yield of the paraffin-base materials to make the production of motor oil from them commercially possible. This development, members of the petroleum industry contend, will revolutionize the entire motor-oil picture and remove the dominance that certain eastern crudes have had in this particular market.

As Dr. Bray continued his experiments, he soon was manufacturing the new oil in a miniature solvent treating plant. He commenced by introducing the crude oil and propane into a pressure bomb. Propane went in first, under pressure of 180 pounds to the square inch to prevent return to a gaseous state. Then the oil stock was introduced and the bomb revolved, end over end, to mix the contents thoroughly.

After 20 or 30 whirls the bomb was returned to an upright position, the asphalt settling out of the propane solution and being drawn off as a semi-solid. The next step in the refining of the motor oil in the miniature plant consisted of the removal of wax. To accomplish this, Dr. Bray proceeded to transfer the asphalt-free solution of propane and oil to what he termed the "chiller."

In the "chiller" the gage registered 180 pounds, and as the pressure was gradually released, permitting the propane to evaporate, the pressure dropped to normal and the temperature to 40 degrees below zero. The solution at this temperature was then forced through a pressure filter. The wax, by that time having been reduced to a semi-solid form, was completely removed from the solution by the filter, while the wax-free solution was drawn off into beakers, and then transferred to



Withdrawing propane precipitated asphalt under pressure of 180 pounds to the square inch from a miniature refining plant bomb. See description in the text

agitators where it was subjected to a solvent treatment using liquid sulfur dioxide to remove the unstable materials and the low grade and low gravity oils.

Thus, for the first time, asphalt, wax and other undesirables are removed and refined oil obtained in a single continuous process.

The next step lay in applying the method in large-scale production. By following five general steps—vacuum distillation, propane de-asphalting, propane de-waxing, double selective solvent refining, and final finishing for uniformity of color and grade—at its Oleum plant, Union now finds it possible to choose only those fractions desired, discarding the others.

Importance of the new method to the petroleum industry can hardly be over-emphasized. As Mr. Earle W. Gard of the Union Oil Company, points out:

"Many of our greatest and most useful inventions are the direct result of years of research. The development of the process and equipment for the manufacture of Triton is no exception to the rule in this respect. Advancement in the manufacture of lubricating oils has been slow and no previous invention in this field can even closely compare with the general effect that the development of methods of solvent manufacture of lubricating oils will have on the petroleum and allied industries."

Right: Experimental equipment used to demonstrate the removal of wax from lubricating oil stock. The solution of propane and stock, chilled to 40 degrees below zero, is being drawn through a filter into flasks. Note frost on the equipment. _Below:_ Beaker at left shows de-waxed oil and one at the right the wax obtained in the process. _Lower left:_ Wax which has been frozen out of solution and collected on filter in the propane treating drum shown at right

This new refining method marks a definite step in a virtual revolution now taking place in the manufacture of lubricating oils. Until recently most lubricants were "acid refined." That is, the crude was first broken into fractions of different weights by distillation. These distillates were treated by mixing with strong sulfuric acid, which formed a black sludge by charring the undesirable portions. The black sludge was drawn off, and the oil neutralized with caustic soda and washed with water. In order to remove more of the colored materials, some oils were mixed with a porous clay and filtered. If the crude contained a high percentage of wax, the wax was removed by mixing the oil with some diluent, such as gasoline, and chilling the mixture. The wax separated out.

SEVERAL years ago Dr. Edeleanu, a Roumanian petroleum technologist, discovered that liquid sulfur dioxide —the kind used in household refrigerators—has the power of dissolving undesirable constituents from a kerosene distillate, leaving the more desirable portions untouched. This system was later extended to lubricating oils. In actual operation, the oil stock is mixed with the sulfur dioxide which dissolves the undesirables and drops with them to the bottom of the vessel, while the desirable oil, soon ready to reach your crank-case, rises to the top with a very small amount of sulfur dioxide in it. Distillation removes the sulfur dioxide from both the settled extract and the raffinate which rises to the top. In this method a remarkable separation has taken place, since neither portion has been altered or destroyed as in acid treatment. Tests show that both the raffinate and the extract may be called lubricating oil, though the raffinate is far superior.

IN the development of Triton oil, production was carried on in semi-commercial plants for nearly two years before a commercial plant was completed at Oleum, California.

An interesting sidelight on some of the difficulties often encountered in the commercial production of a new product concerns the specifications of the propane unit at Oleum. It was found that no steel was available for the construction of the chiller units, which had to withstand operating pressures up to 200 pounds per square inch at 100 degrees, Fahrenheit, and then function at atmospheric pressure and a temperature of 40 degrees below zero. Ordinary steels after being chilled to this low temperature were found to be brittle, fracturing easily. Steel manufacturers, presented with the problem, worked for several months in co-operation with the oil company's representatives to develop a nickle-alloy steel which proved satisfactory for vessels of the size required in the new refining process.

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¶ While the foregoing article was being prepared for publication, announcement was made by Socony-Vacuum Oil Company, Inc., of the Clearosol solvent process of refining motor oils, which makes use of propane and chrysalic acid for eliminating from crude oil those constituents which are undesirable.—*The Editor.*

Sundials and Their Construction

Part VIII—Lines of Declination for Dials in Planes Parallel to the Earth's Axis

By R. NEWTON MAYALL
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For a long time after the introduction of the clock, the erection of sundials continued, especially in Europe and the British Isles. Many pillar dials may still be found in the rural districts, some of them occupying prominent positions in the town squares.

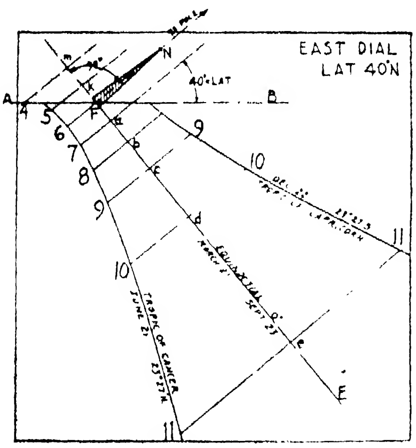


Figure 1

The pillar dial usually contains four vertical dials, each facing a cardinal point of the compass. The north and south dials have previously been described, and the construction of the lines of declination for them has been shown.

From the preceding articles, the reader has doubtless noticed that a single dial does not show the time of sunrise and sunset, throughout the year. This deficiency may be overcome by employing a combination of dials, such as that on the pillar dial, where the time of sunrise is shown by the east face, and sunset by the west face. Therefore the reason for the prominent position occupied by the early pillar dials is evident and, although analogous to the town clock of today, they were more useful.

The planes of the direct east and west vertical dials and the polar dial lie parallel to the axis of the earth. If the lines of declination are to be inscribed on these dials the most satisfactory gnomon will be one shaped like a pin, because the point or apex will be both style and nodus.

Figure 1 shows an east dial computed for 40° north latitude, with lines of declination properly drawn upon it. The gnomon has also been drawn in the diagram, for clarity. The style and nodus are coincident at the point N; the height of the style is equal to the height of the perpendicular style, FN; the foot of the perpendicular style intersects the 6 o'clock line at F.

The equinoctial line FE is drawn through the foot of the perpendicular style and at right angles to the 6 o'clock line.

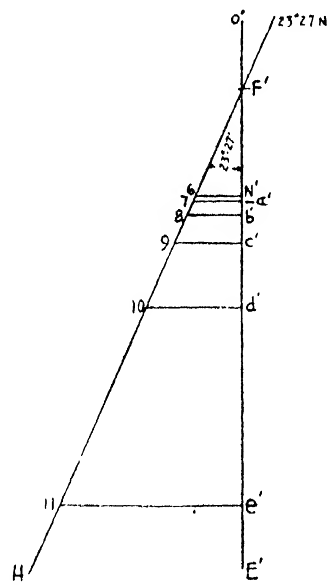


Figure 2

On vertical dials, the horizontal line is drawn through the point where the equinoctial line crosses the 6 o'clock line, or through the foot of the perpendicular style. On the east and west dials, these two points are coincident at F; therefore, the line AB, drawn through F, making an angle with the hour lines equal to the latitude of the place (in this case 40°) will be the required horizontal line, for this dial.

The construction of the lines of declination for the east dial follows:

Draw the line $F'E'$, Figure 2, representing the equinoctial line; and through F', draw $F'H$ making an angle with $F'E'$ equal to the sun's greatest northern declination (23° 27′).

Lay off from F' the distance $F'N'$ equal to the height of the style.

Take the distances from N (Figure 1) to a, b, c, d, and so on (the points where the equinoctial line cuts the various hour lines), and lay these distances off from F' (Figure 2) to a', b', c', d', and so on.

Through the points N', a', b', and so on (Figure 2) draw lines perpendicular to $F'E'$, cutting the line $F'H$ at 6, 7, 8, 9, 10, 11 (the figures represent the corresponding hour lines in Figure 1).

Now lay off the distances $N'6$, $a'7$, $b'8$, and so on (Figure 2) on Figure 1, so that $F6=N'6$, $a7=a'7$, $b8=b'8$, and so on. Then, a line drawn through the points 6, 7, 8, 9, 10, 11 (Figure 1) will show the path of the shadow of the nodus when the sun reaches its greatest northern declination.

To find the points on the hours before 6 through which the line of declination is to be drawn, make $k5$ and $m4$ (Figure 1) equal to $a'7$ and $b'8$ (Figure 2), respectively.

In the same manner all other lines of declination can be plotted on the dial plate.

The horizontal line is a useful addition to an east or west dial, for by it the time of sunrise and sunset throughout the year may be estimated.

In Figure 1 the line of declination for December 22 cuts the horizontal line between 7 and 8 A.M., and a little before 7:30 A.M., apparent time. Therefore, on December 22 the sun will rise shortly before 7:30 A.M.

According to an almanac computed for 40° N. latitude, the sun will rise, on

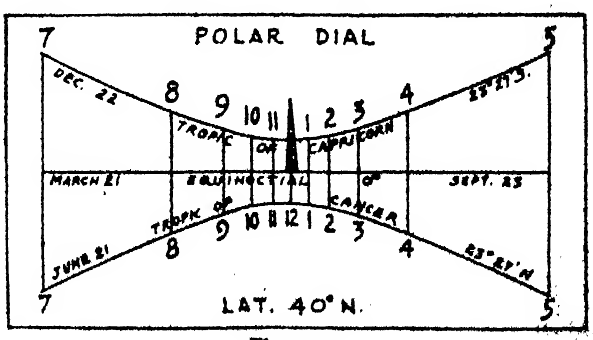
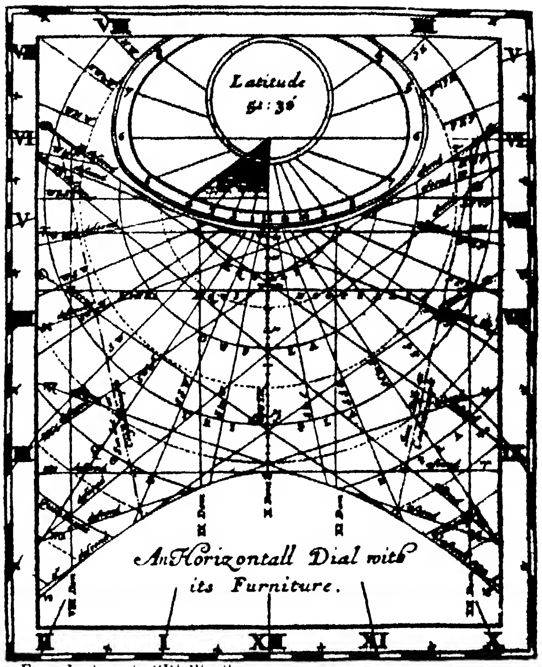


Figure 3



From Leybourn's "Dialling"

Figure 6: A 17th Century horizontal dial with its complicated furniture, a typical example of what is possible—if one likes complexity

December 22, at 7:20 A.M. apparent time. The time may be more accurately measured on a large, carefully constructed dial.

If Figure 1 is looked at from the back, a west dial for the same latitude, with its lines of declination properly drawn and designated, will be seen. The morning hours will become the afternoon hours, and the horizontal line will show the time of sunset.

A POLAR dial, with its lines of declination, is shown in Figure 3. The construction of the lines is the same as for the east dial. The horizontal line is not shown on this dial, because it would be of use for only about one month during the year. It is, however, constructed in the same manner as that for the equatorial dial, described in the September number.

The polar dial is seldom constructed, although it may be adapted to many situations. The symmetry of its lines adds to its attractiveness.

There is another easy method of drawing the lines of declination, which employs tables showing the altitude of the sun, and will no doubt appeal to those readers who have access to such tables.

The United States Hydrographic Office publishes many books useful to the navigator. Two of these books, designated as No. 201 and No. 203, show the altitude and azimuth of celestial bodies for stated values of declination and latitude, which are useful to the diallist. Publication No. 201 is now out of print and consequently difficult to obtain, but No. 203 is the current publication and it contains the same tables.

The method of constructing the lines of declination, by means of these tables, will be briefly outlined. Its application to the various types of dials is the same as that shown in the following example, where the path of the shadow of the nodus is plotted on an horizontal dial in latitude 40°N., when the sun has a declination of 20°N.

From the tables mentioned above, take out the values for the altitude (angular distance above the horizon) of the sun, for each hour of the day, in latitude 40°N when it has a declination of 20°N. (The values, as shown below, have been taken from the United States Hydrographic Office Publication No. 201.)

HOUR	Altitude of Sun
12 noon	70°
1 P.M. and 11 A.M.	66°14′
2 " " 10 "	57°29′
3 " " 9 "	46°48′
4 " " 8 "	35°26′
5 " " 7 "	23°58′
6 " " 6 "	12°42′

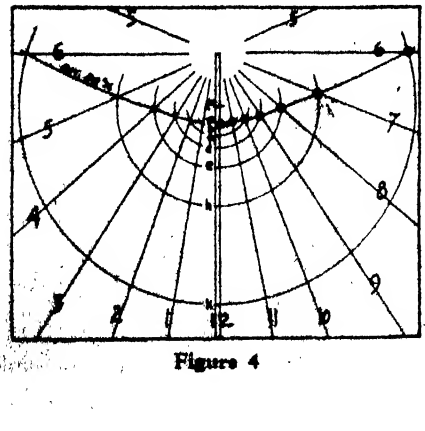


Figure 4

In Figure 5, the line $F'k'$ represents the substyle line on the dial. The foot of the perpendicular style is noted at F' and the nodus at N.

Now draw lines from N to the line $F'k'$, making angles with $F'k'$ equal to the altitudes shown in the above table. Thus, angle $F'a'N=70°$; angle $F'b'N=66°14'$; and so on.

Then, in Figure 4, lay off from F (the foot of the perpendicular style) the distances Fa, Fb, Fc, and so on, equal to $F'a'$, $F'b'$, $F'c'$, and so on (Figure 5) respectively.

With center at F (Figure 4) and radii Fb, Fc, Fd, and so on, describe arcs cutting the corresponding hour lines (radius Fb cuts the 1 and 11 hour lines; Fc cuts the 2 and 10 hour lines; and so on). Through the points thus found

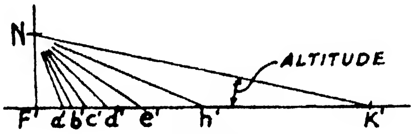


Figure 5

on the hour lines, draw a curved line, which will be the desired line of declination.

All other lines of declination may be plotted in the same manner.

BY the end of the 17th Century almost every conceivable type of dial had been constructed; and gnomonics had become a finely developed art, to which "well informed gentlemen gave careful consideration." Since that time few new dials have been devised, and most of these have been modifications of earlier types.

There seemed to be no limit to the amount of "furniture" that the early diallists were wont to place upon a single dial. Figure 6 is an admirable example of such a dial, which has more lines than most people would want to compute. Aside from the time of day the facts depicted on this dial are varied and interesting, and a short description of them will not be amiss. Upon this dial are inscribed:

1—Lines of declination, which show the path of the shadow of the nodus when the sun is on the equator and in the two tropics. On the meridian or substyle line is marked the position of the shadow of the nodus for each degree of declination.

2—Azimuth lines, which show the position of the sun throughout the day, with respect to the points of the compass; or its angular distance east and west of the meridian.

3—Lines showing the length of the day; the time of sunrise and sunset.

4—The dial is constructed for London, but the time of sunrise and sunset in Constantinople is also shown.

5—Lines showing the rising and setting of the signs of the zodiac (ascending and descending signs); and the position of the sun with respect to the signs. These lines were used by astrologers to tell the position of the sun in relation to its cuspis, and they did not have any astronomical application.

6—Lines showing the altitude of the sun.

7—Declination of the sun at its entrance into the various signs.

It is evident that the computation of such a dial would require a good knowledge of celestial mechanics; also, in the 17th Century, the services of an expert engraver.

There are many collections of sundials and early astronomical instruments in this country—most of them private. Among the most noteworthy collections, open to the public, are those in the Adler Planetarium, Chicago; Industrial Museum, New York; Metropolitan Museum of Art, New York; and the Boston Museum of Fine Arts.

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The concluding article of this series will describe the armillary sphere.

NORRIS DAM

Storage and Flood Control . . . Link in Tennessee Valley Program . . . Will Produce Power . . . Unique Engineering Problems . . . Economic Significance

By **BARTON M. JONES**
Construction Engineer

NORRIS DAM, on the Clinch River 25 miles northwest of Knoxville, Tennessee, has a three-fold duty. It will develop power during certain months of the year; it will aid navigation and flood control materially; and it will have the effect of increasing greatly the "firm," or dependable, power at run-of-the-river hydro-electric plants downstream on the Tennessee River, such as Wilson Dam at Muscle Shoals, and Wheeler Dam, under construction near the Shoals.

All three functions are vitally necessary if the Act of Congress creating the Tennessee Valley Authority is to be fulfilled to the letter and in spirit.

Norris Dam itself is essentially for storage purposes. Designed for the foothills in eastern Tennessee, it will back up an immense lake, 83 square miles in area, containing 3,600,000 acre-feet of water, and having a shore line of 800 miles. Such storage is not possible in low, flat sections of the Tennessee as at Muscle Shoals. Generally speaking, a plant like Wilson Dam on the Tennessee, must "take the water as it comes." When the river is high, as it is during approximately nine months of the year, a generous amount of power may be generated. But when the river is low, little power in comparison is possible. Estimates have indicated the output of power possible at Wilson Dam may run from 65,000 KW to as much as 200,000 KW. In other words, the firm, or dependable, power output is low.

AN entirely different picture is presented with the completion of such a dam as that of Norris, which is on a tributary of the Tennessee. Here water may be stored during the months of the year when it is not needed downstream. But when the "mother river" drops, the stored water at Norris may be released. There it will generate 132,000 horsepower of current, and the same water, passing down the Clinch into the Tennessee, will increase the flow of the latter during the dry months and increase the output of dependable power four or five times at the run-of-the-river plants. Linked together into an integrated, unified system, the dams will harness the power of an entire watershed.

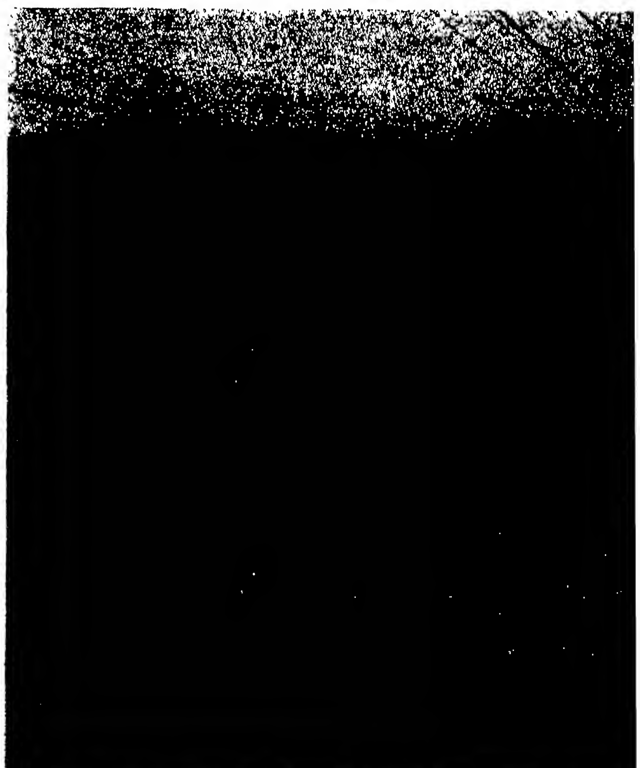
Of equal importance to its power-producing duties, is the relation of the reservoir to navigation and flood control. Reservoir dams hold back water not needed in wet months and release it when most needed. Thus the possibility

A rigger at Norris Dam on the cable across the river

of such a river as the Tennessee going on a rampage after the completion of the series of dams in the Valley will reach the vanishing point. And thus, too, will the navigability of the river be heightened due to the leveling of the stream flow.

That is the first picture that strikes the eye when considering a storage plant such as Norris Dam. However, its significance is deeper still when the more fundamental purposes of the Authority are understood. The Authority is charged by Congress with the development of an entire watershed embracing more than 40,000 square miles. Development of a yardstick by which to measure the cost of generation and distribution of electricity, and to find ways to widen its use in homes and on farms, is but one of the Authority's duties. The development of new and better forms of fertilizers, or plant foods, is another vital one; the tremendous problem of stopping the erosion of the soil is another; the maintenance of a proper balance between agriculture and industry to avoid stagnation of either in the future is a fourth; the reforestation of wide areas which are submarginal is another. And there are many more. All, however, have a common aim: the utilization of the resources of an entire watershed so that the burdens of life are reduced to a minimum.

ALL are inexorably bound together if the common aim is to be achieved; and all must be retained in one's mental background when considering the real



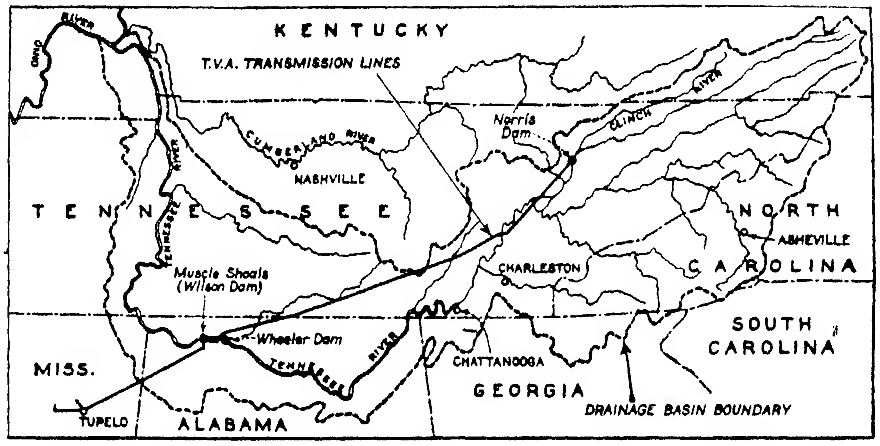
importance of such a project as that of Norris Dam.

Norris Dam will be a concrete structure, 1850 feet long, 253 feet high. The wall of water it will hold back requires a dam of mighty strength. The concrete wall will be 210 feet thick at the base and 213 feet high to the crest of the spillway. Forty feet higher still will be a 22-foot roadway for vehicular traffic. The cost is estimated at 35,000,000 dollars for the dam, power house, and reservoir. The preliminary work has been completed and the work on the dam proper is approximately one fifth finished as this is being written.

THE preliminary work consisted of a number of subsidiary but important undertakings. Test borings, some as deep as 400 feet, were taken to ascertain the stratification, type of rock, and feasibility of building a dam at the site.

A heavy-duty temporary bridge had to be thrown across the Clinch River for transporting materials. A heavy-duty highway was constructed for hauling materials from Coal Creek, a distance of four miles. Roadways had to be developed at the dam site. Warehouses, office buildings, first aid facilities, and repair shops were erected at the site.

Complete housing, commissary, and recreation facilities have been built for the workers at the edge of the new town, Norris, four miles away. Meanwhile, aerial surveys were made of the reservoir area to be inundated and 1000 men are clearing timber and brush along the 800-mile shore line.



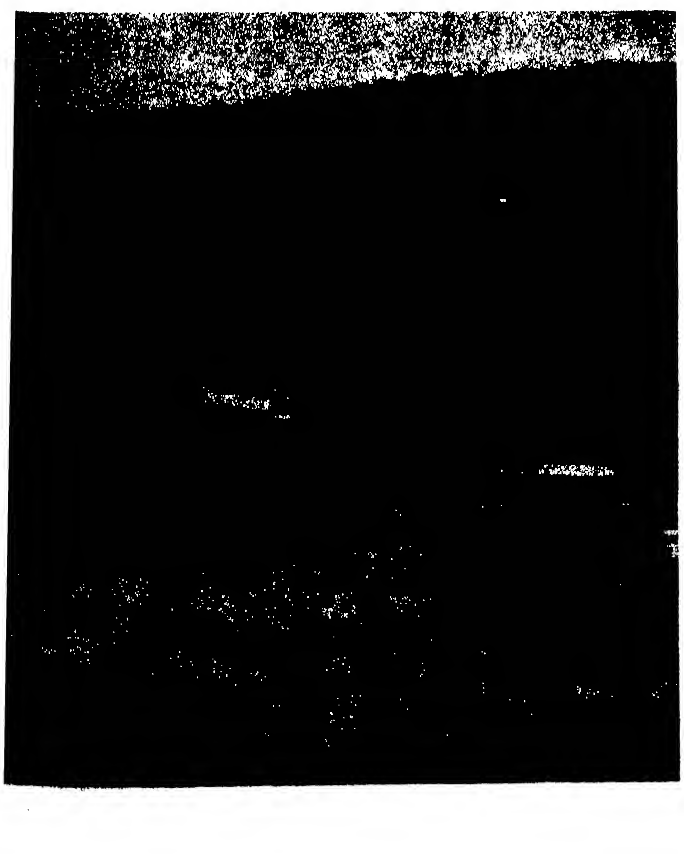
The Tennessee Valley watershed, showing dams and tie-in transmission line

The first stage of the work on the dam itself called for the diversion of the Clinch in order that a foundation might be prepared. This was done by means of timber-crib, clay-and-rock-filled coffer dams. Since the Clinch is only about 300 feet wide, only three of these were required.

The first-stage coffer dam, extending part way across the Clinch from the east bank and about 475 feet up and down stream, was completed and unwatered January 28, 1934.

Excavation operations on the east hillside were extended into the bed of the river, and five 12-yard dump trucks with two electric and two gas-electric power shovels were put on this work. One of these shovels dug the foundation for the power plant, while another cleared a foundation for part of the apron of the spillway. The other two stripped the overburden and excavated rock from the hillside over the area to be covered by the base of the dam.

Norris Dam on the Clinch River shortly after pouring of concrete had been started in east coffer dam



Excavation necessary for the foundation for the entire dam will require the removal of 127,500 cubic yards of earth and 158,000 cubic yards of solid rock.

The rock in the vicinity is hard dolomite, a limestone formation with part of the calcium replaced by magnesium. Sixteen wagon drills and 30 jackhammer drills are busy night and day reducing this rock to movable size. Three air compressors, each with a capacity of 2300 cubic feet per minute, and one with a capacity of 1100, all at 100 pounds pressure, are used in this work. Six 12-yard and two 8-yard dump trucks, owned by the Authority, and a fleet of smaller, rented trucks are in circulation 22 hours a day in four $5\frac{1}{2}$-hour shifts, carrying away the earth and rock.

The placing of concrete began some time ago in the east part of the river bed. Gaps will be left in the dam to take care of the flow of the river, after the third stage coffer dam will have been thrown up to uncover the middle part of the river bottom. Excavating operations will then be carried into this remaining portion of the stream bed.

While excavation of the foundation was being done, a complete plant for production of stone and sand aggregates and for mixing concrete was installed on the west side of the river.

ON the west side of the Clinch, a small draw leads down to the river between the dam site and the mouth of Cove Creek. It was found that beneath its few feet of dirt, the north hillside of this miniature valley is entirely of dolomite rock, of a quality satisfactory for the 2,000,000 tons of crushed rock needed for the job. This fact eliminated the necessity of building a railroad from the town of Offert for shipping in such unusual quantities of materials, a saving for the Authority of several hundred thousand dollars. The overburden of dirt and clay on the face of this potential quarry was washed or sluiced away by hydraulic pressure to uncover the stone to be quarried.

This was accomplished by running three centrifugal pumps in series, one at the river bank and the others at the quarry floor level, and delivering water to the $2\frac{1}{2}$-inch nozzles at 100 pounds pressure. The water was pumped over a total distance of about 1200 feet and to a height of 600 feet. All of the quarry operations are carried on at levels more than 240 feet above the river.

At the lower edge of the quarry, the trucks dump the rock into the top of a 42-inch gyratory crusher that stands 19 feet high and 15 feet in diameter. This primary crusher is able to reduce a 42-inch boulder to rocks six inches in size and smaller. All crushed rock is trans-

One stage of the concrete mixing plant. Here different sizes of rock, sand, and cement drop from storage bins to tanks where the proper batches are weighed

ported by means of a 36-inch rubber belt conveyor, for a distance of 335 feet across the draw to the secondary crusher on the south hillside.

Along this hillside is a straight-line series of operations leading to the preparation of concrete. The six-inch rock is reduced by the secondary crusher and run through a screening plant to produce four different sizes of crushed stone aggregate. A part of this crushed stone is passed through the hammer mills and reduced to sand which will be screened into two sizes. This stock is stored in a row of six separate piles over a concrete recovery tunnel in the top of which are several ports and gates under each pile of stock. A conveyor belt running lengthwise of the tunnel carries any particular size of stock to storage bins above the concrete mixing plant.

The batching equipment under these bins on the mixing plant weighs exactly the right amount of each size needed to feed the mixer. A cement silo of 6000-barrel capacity, with pumping equipment for filling, stands nearby. The mixing unit is a cluster of three 3-yard mixers, capable of producing 4000 cubic yards of concrete a day.

One million barrels of cement, 425,000 yards of sand, and 825,000 yards of crushed stone will be fed into these mixers. Tilting hoppers on transfer cars hauled by gasoline-electric locomotives deliver the concrete to 6-yard bottom-dump buckets on the cableways. The buckets remain attached to the cableway.

High above the bed of the river on each side of the Clinch stand the four cableway towers on their two two-rail runways. The two head-towers on the west side stand 75 feet high on a bench cut into the hillside 340 feet above the river; the tail-towers, 1950 feet distant across the river, stand 110 feet tall on an earth fill 100 feet lower.

The cable spanning the river is three inches in diameter, contains 165 strands of special steel wire, and has a total tensile strength of 550 tons. The cableway is rated to carry a load of 18 tons when in use. To resist this loading, and the weight of the cable, which itself weighs 28 tons, the base of each tower is unusually massive in structure. Also, there is horizontal anchorage in the form of a horizontal thrust rail.

THESE cableways will see considerable service as the work progresses. One million yards of concrete, 2325 tons of reinforcement steel, timber, turbines, and machinery—all will be swung out into space and dropped carefully into position as a part of the routine of construction.

Though primarily a storage and flood control project, Norris Dam will include a power plant containing two 50,000 KW generating units. It should not, therefore, be regarded as an undertaking separate from all other Authority projects. It is, rather, an important link in the power program, the ultimate purpose of which is to utilize completely all the vast water power resources of the Tennessee watershed now flowing practically unretarded to the sea.

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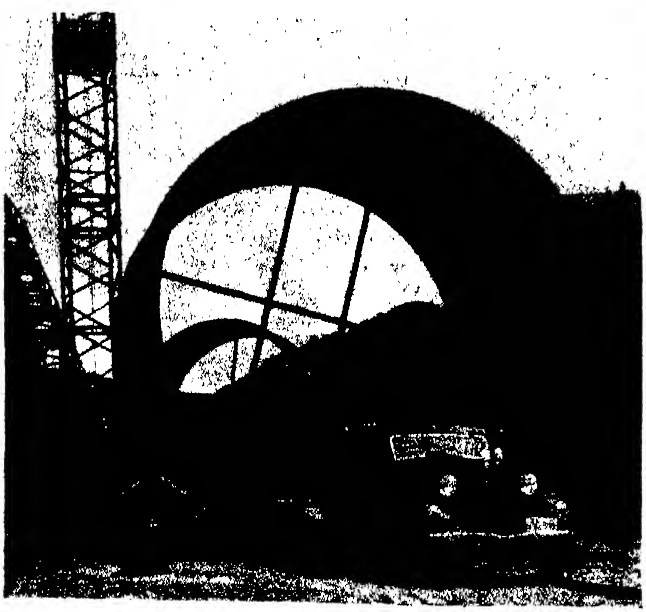
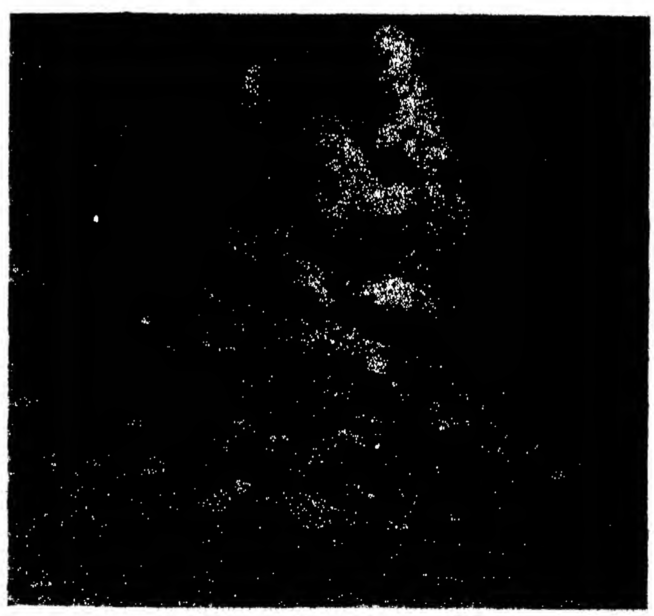
Realism in advertising illustrations is rapidly gaining ground by reason of advances in photographic technique. An article to be published soon tells of this work, and the amateur photographer, reading between the lines, will find many hints that will help him in his hobby.—The Editor.



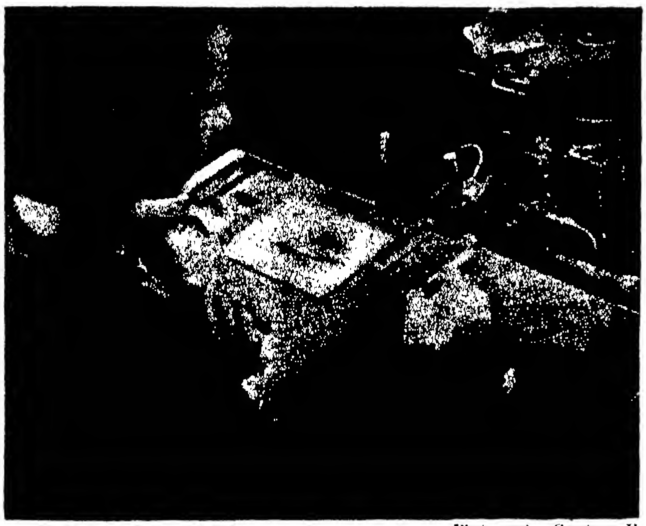
Sections of penstock tubing for Norris Dam; 20 feet in diameter, these sections are electrically welded at dam site



Quarry on the hillside above the dam site just as a blast was set off to produce broken stone for primary crusher

Delicate torsion balances check the diameter of filament wire before it is coiled. Eight-inch lengths are weighed

Automatic winding machines form the fine wire into coils, the operator checking the work through a microscope



The straight filament coils are loaded into a machine where they are bent and drawn into hooks on the supports

Base twisting test to determine if base is properly cemented. Scale indicates strain in pounds applied by the tester

Photographs Courtesy Hygrade Sylvania Corporation

Light in Glass Packages

EVEN a king's ransom could not buy a single modern electric lamp bulb, if only a single one had ever been made. The vast background of research and engineering, the quest for rare materials in far-flung corners of the globe, the laboratory precision and skill required in fashioning the glass and metal parts, and lastly the numerous tests and inspections necessary to insure a truly satisfactory product, would prove appalling in magnitude and extent. Only because lamp bulbs are manufactured by the hundreds of millions, with the aid of automatic machinery, can they be made available to rich and poor alike. Lamp production begins with the filament. In the usual 50-watt lamp, the filament wire is so fine that its diameter cannot be determined by a wire gage; it is accurately measured within 0.00001 of an inch by weighing. Upon accurately maintained diameter depends current consumption, luminous output, and service life of finished bulb. This fine wire is wound into coils or helices so small that, to the naked eye, they appear as straight lengths. In some coils there are 1000 turns to the inch. The tungsten wire is wound about a steel wire core or mandrel which later is dissolved in an acid bath. The filament is picked up by tiny metal hands, bent into a loop and thrown over and drawn up into the support wire hooks. Lead wires are automatically clamped on to the ends of the filament. In the revolving sealex machine, glass bulbs with elongated necks are sealed to the filament supporting mount during the first trip around. Then the air is exhausted during the second trip and the glass tube connecting with the exhaust port is tipped off, making a complete glass seal. If the bulbs are to be gas-filled (modern lamps of 40 watts and larger are filled with argon gas) the process is the same except that gas is introduced in the bulb after exhausting. The lamps are then provided with the brass screw base connected to the wire leads. This is accomplished on a basing machine which attaches the base shell to the bulb by melting and baking the cement lining, and automatically solders the leads. Meticulous care in making lamps is only half of the story of a quality product. The other half is of even greater importance, for rigid and relentless inspections and tests provide means of checking quality and insuring that only the proper grade lamps reach the ultimate consumer. Even after lamps have been placed in warehouses they are not beyond the long arm of the inspection department, which takes cases at random and conducts rigid tests as a periodical checkup on the entire stock.

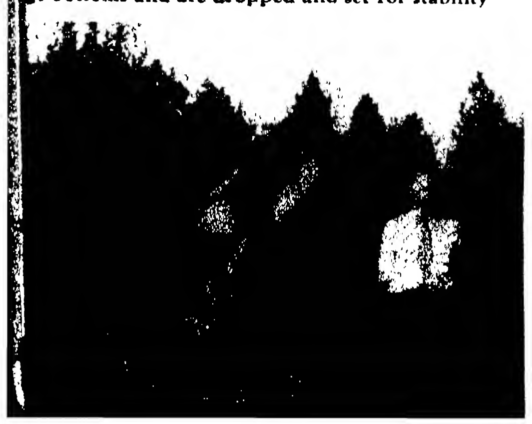
AMATEUR TELESCOPE MAKERS

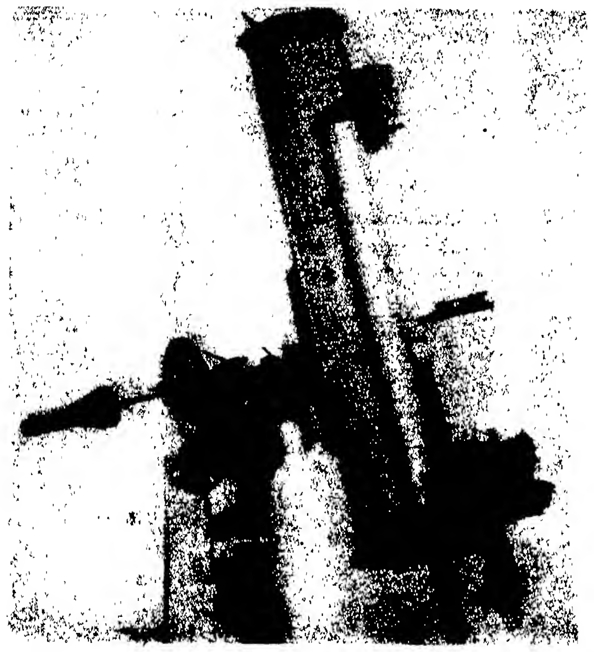
EXHIBIT ORIGINALITY AND INGENUITY

clean piece of design and workmanship is the inch telescope with finder, made by L. F. Berry, 6 Consumers' Power Building, Jackson, Michi- n. It was modified from blueprints by John M. erce. Duraluminum tube. The finder magnifies diameters and has a 6-degree field. Mirror uminized. This telescope is driven by a 6-watt E. Telechron motor unit from an oil furnace

Below, right: Lew Wallace of Gowanda, New York, was resourceful in seeing possibilities in many things when accumulating his telescope mounting. Chemical or some other kind of analysis reveals the following constituents: One old hot water tank, for tube, eked out with a roll of sheet iron. One inverted Chevrolet motor block for polar axis. One solid iron cross bar an inch and a half thick, from an old mill, to which the declination axis is attached. One 30-inch wooden declination circle, one small grindstone and one motor car hub, these three together forming the counterweight. The net tonnage above the pedestal is given as two tenths, yet its maker says it moves at the touch of a finger. It gets there, though it does perhaps lack sex appeal

low: The feature of a 12-inch reflector made Tracy D. Edmonds, 815 Foster Avenue, Coeur Alene, Idaho, is its really adequate truck (it is ocally portable type). Note that this is not a set bedroom casters but a whole front-axle assembly, h handles of the wheelbarrow type for pushing about. The two uprights between wheels have e bottoms and are dropped and set for stability





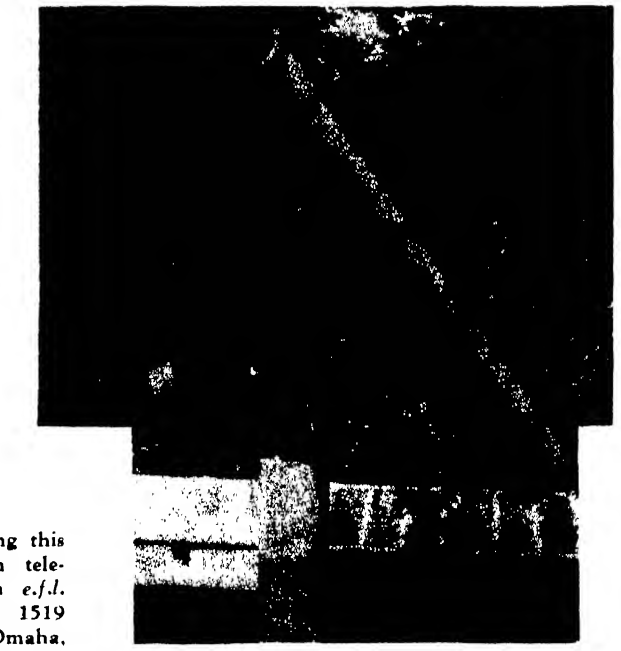
A lot of neat equipment is embodied in a 6½-inch, *f*/6 reflector made by Raymond C. Gagnon, 70 East St., Holyoke, Massachusetts. Hexagon tube of sheet metal, a three-inch photographic camera attached. Three-inch finder. In box near top is a roll of motion picture film. Clock drive on pedestal. Setting circles. By substituting a plate for the mirror, removing prism, and attaching 6-inch lens at top of tube, this telescope is convertible into a camera. The entire assembly looks trim, neat, practical, and sound

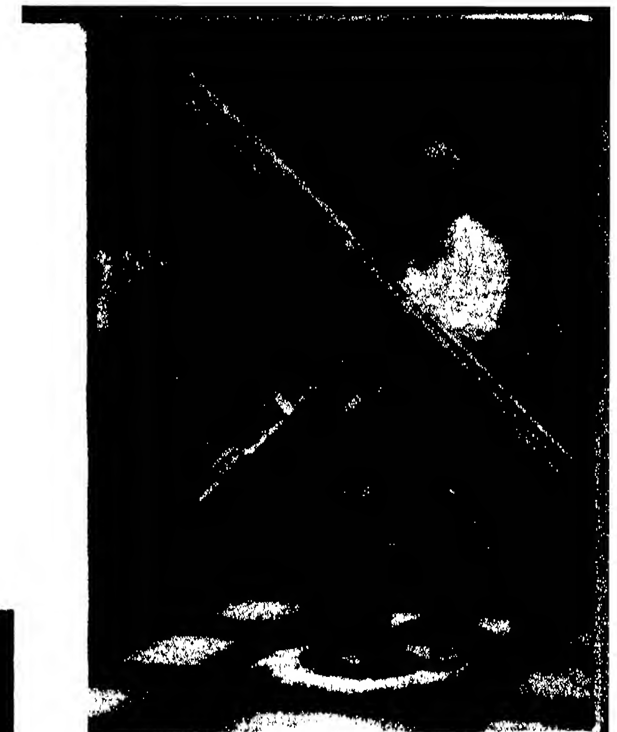
Right: What looks like an anti-aircraft gun is but a refracting telescope. It is uniquely mounted by means of a pair of steering worms from old cars, their housings welded together. One is for motion in altitude, the other in azimuth (the same equipment could be rigged equatorially). One steering wheel spider shows in front, the other faintly behind the finder. A tube hanging from the eye end is a temporary counterweight. Devised and made by J. Janes, 1332 Twelfth Avenue, Saskatoon, Saskatchewan, who states that the gears work smoothly

Left: When making this 10-inch Gregorian telescope of 150-inch *e.f.l.* James E. Myers, 1519 Olin Avenue, Omaha, Nebraska, switched the counterbalance around to the south end of the polar axis. It is a sitting-down telescope with controls handy at all times. Declination axis is hollow, with taper fits for yoke, permitting any sized yoke carrying any sized telescope to be attached. The bar which carries the counterweight is coarse-threaded—two threads per inch—which facilitates quick adjustment for different tubes, of which the maker owns four. Box in background is a cover for mounting. "It took time and a lot of patience," Mr. Myers writes, but at last came success

TELESCOPES MADE BY SCIENTIFIC AMERICAN READERS

Below: "The results on Jupiter with 415 diameters magnifications have been superb," according to the maker of this 9¼-inch reflector, Frederick Ellis, 1363 S. W. Montgomery Drive, Portland, Oregon. The flat, which was made by John E. Mellish, is mounted on an adjustable three-legged spider and works perfectly, Mr. Ellis says. The mirror was polished on an *H.C.F.* lap and he adds that he swears by *H.C.F.*





Looking like a field gun and glistening in the light is the very sophisticated looking telescop 6-inch, made by Edward R. Perry, M. D., presi of the Amateur Telescope Makers and Astrono of Tacoma, Washington, the mirror having made by Alan R. Kirkham of the same organ tion. The tube is a ten-stave wooden porch col and Dr. Perry believes he is the first to use suc tube for a telescope. He writes enthusiastically the advantages of wooden tubes, of which he a half dozen. One is better temperature ef

Below, left: A discarded Ford motor block makes a neat, solid, accurate, and generally excellent polar axis, so Fred D. Ayres, 2236 Sherman Ave., Evanston, Illinois, found when he discovered the original idea of using one while a student at Northwestern University. But he credits the design to his father. He states that the telescope can be clamped in declination by means of two brake shoes tightened against the shaft on opposite sides, with wing nuts

Below: A large reflecting telescope made by Edv F. Bowman of the Telescope Makers of Ka City, Missouri (1406 Ewing Avenue). The cl like pedestal is not a chair, but the frame o electric stove. What object on earth has not adapted to excellent use in some amateur's scope! It is alleged to be morally justifiable to c and confiscate any object around home for use telescope, all in the interests of "Sacred Scie

RESEARCH FOR INDUSTRY

Institute's Creative Research . . . For Self . . . For Industrial Sponsors at Cost . . . End-Product Belongs to Sponsor . . . Avoids Abstractions and Curiosity

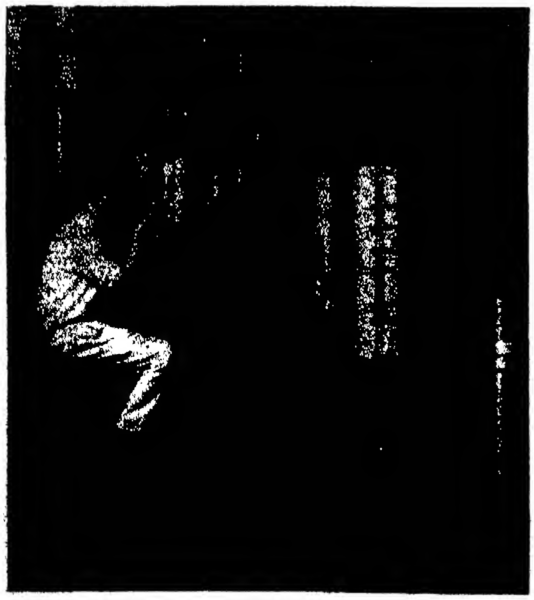
By CLYDE MITCHELL

IN Columbus, Ohio, there is a scientific organization which will take a manufacturer's research problem into its laboratory, study it, find a solution if possible, and charge him only nominal costs. The problem might be one of lengthening the life of gears, determining the quality of an alloy to be used in aircraft, or finding a new use for coal; whatever it is, if it relates to metals or fuels, a highly specialized scientific organization is available to him.

This unique service is being given by the Battelle Memorial Institute, a foundation endowed to make this sort of contribution to industry, to carry on creative research for the advancement of science, and to function as an educational institution. It is only five years old but its growth, its output, and its scientific achievements have been such that an appraisal of its operating methods from the practical angle can now be made.

The outstanding feature of operations, the feature which makes the Institute distinct from other research foundations in the industrial field, is its sponsored research plan whereby industry may utilize the scientific ability and technical equipment of this group. Its operation is extremely simple and can be illustrated by following through a typical case:

LAST year a manufacturer of automotive bearings wished to improve his product so that it would stand up under more severe service. He brought his problem to the Institute and a preliminary survey was made to determine just what the possibilities were. The project was found suitable, a program was laid out, and the manufacturer was invited to co-operate in picking out a research engineer to oversee the work. When this man had been chosen, he was given a laboratory of his own and all necessary facilities were placed at his disposal. The manufacturer was given an estimate of costs before the work began and he was kept informed of progress at regular intervals. To all intents and purposes the sponsor was having research done in his own plant since the work was carried on in complete secrecy by his request. The results—the development of a new bearing metal using cadmium instead of the ordinary alloy base—was his to patent if patentable.



Determining elongation in a number of creep tests of steel. Telescope micrometer is used

The procedure is the same in all cases whether the sponsor be a small manufacturer or a large corporation. The only requirements are that the problem be related to metals or fuels. The Institute, however, does remain judge of the suitability of the problem. Before acceptance, Clyde E. Williams, director; Dr. H. W. Gillett, chief technical adviser; and the staff must satisfy themselves that there is a good chance of obtaining favorable results and that conditions of operation are such as to aid rather than retard reaching the objective. It is a simple provision yet of benefit to both sponsor and Institute, since it has been found to insure productivity of effort.

The fact that research is done not for profit naturally has a very strong appeal, particularly to the industrialist whose problems are so intermittent or specialized that he is not justified in establishing a research organization of his own. At the same time large concerns, having their own laboratories, have used Battelle because of the specialized service and for the less obvious reason that creative research is carried on there. It is perhaps one of the most significant things about the operating plan.

Highly accurate equipment used in metallographic inspection of metals

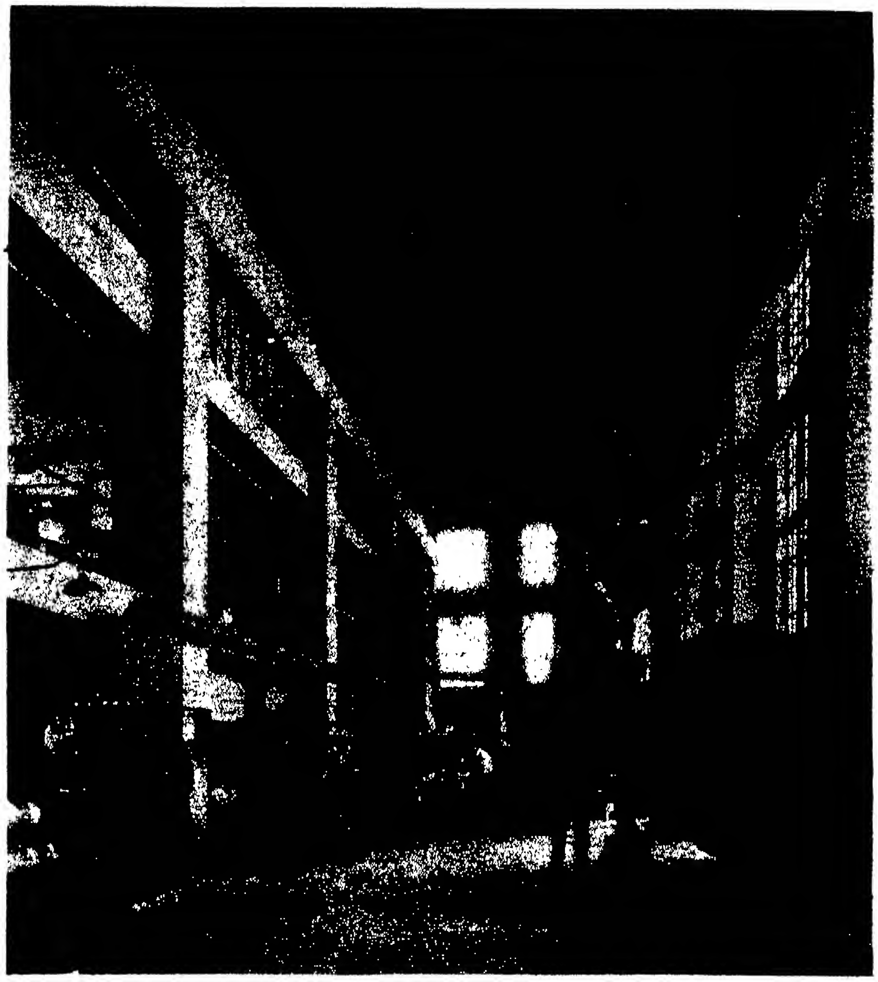
The contribution this organization is able to make to industry through its sponsored research plan is aided by the creative research because it fortifies the scientific detachment necessary for impartial achievement. Scientific organizations, true to their cause, must be able to see facts and state them regardless of their implications, and this is possible in this case because of the ample endowment which assures freedom from the pressure of commercialism. The Institute has no need to get sponsored projects. It could continue to operate indefinitely without a single outside research job and for that reason it can give sponsored projects the same truly scientific handling as its endowed work.

There is one difference between endowment fund researches and sponsored work. The approach is the same, the equipment and scientific training are identical, but the character of problems is different. Sponsored problems very naturally have to do with specific problems in industry which may have as an objective the creation of a new use for

a product or the bettering of the product in old uses. For example, a group of copper producers and fabricators sponsored research to discover new uses for the red metal, while a producer of metal foil wished to have studied the possibilities of surrounding air spaces with this shiny foil for heat insulation. In the former case several new uses were found; in the latter, after study, it was suggested that the metal foil be used for house insulation which is now being done commercially.

When the Institute undertakes its own endowment fund projects, it tackles problems of a more general nature. Its aim can be said to be the working out of problems which industry would not undertake, either because a solution is not vital to its self-preservation or because there would be no immediate value to justify an outlay. Researches of this nature are rarely glamorous. Painstaking effort over a long period of time simply lays down a platform from which more dramatic work can spring.

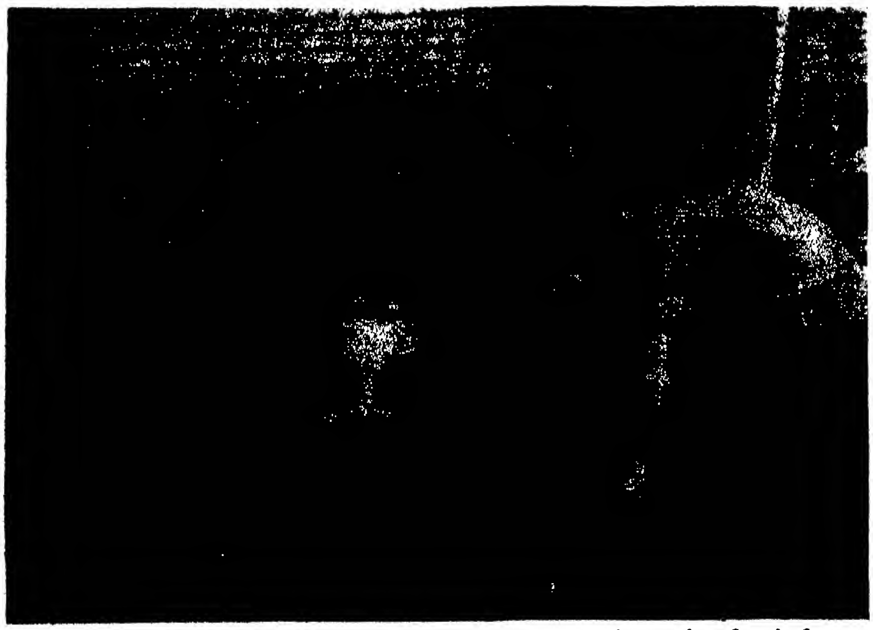
RECENTLY these laboratories perfected a new type of refractory of very light weight. A revolutionary method was developed for making a ceramic having a uniform cellular structure which can be used on a commercial scale with varied applications wherever heat and sound insulation is sought. This is more dramatic than the bulk of endowed projects. When studies were made of low temperature carbonization of coal and the combustion of powdered coal, the latter to reveal the virtue of luminous versus non-luminous flame, the proper fineness for grinding, and the correct size of fire box for best results, the work was not in a field which has much general appeal but the studies were of great value to combustion engineers. Some of the equipment used in this work is shown in the photograph immediately above.



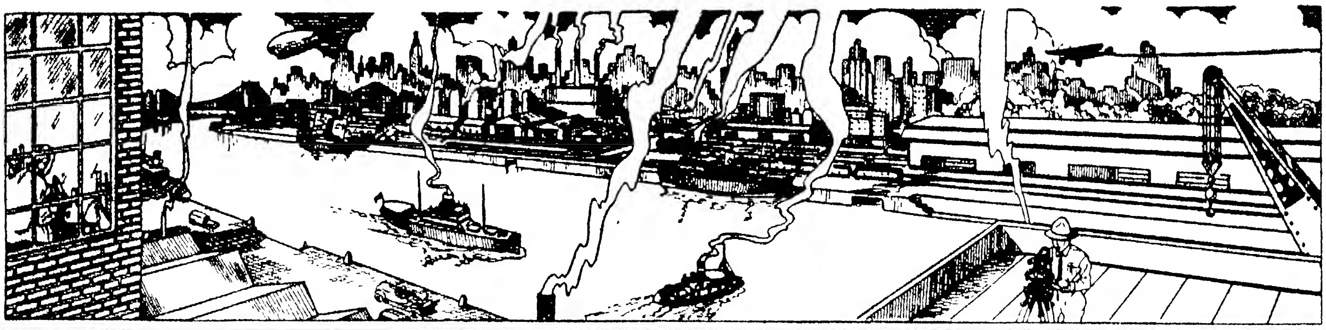
Resembling a large industrial plant, this laboratory with full-sized equipment investigates pulverized coal and other fuel and exceptional power plant problems

The fact that the Institute in five years of life has expanded its staff from a mere handful to more than 85 to handle its many researches is certainly indicative of the vitality of research throughout the depression and it would also seem to indicate that Battelle's operating plan is sound even though it was conceived more than 12 years ago when industrial research was less urgent than it is now.

This plan is the vision of one man, Gordon Battelle, a business man descended from a long line of Ohio industrialists. When he died in 1923, his will revealed that he had worked out a plan with certain definite objectives in view. Battelle wished to further the cause of science but he wanted research to yield tangible benefits in addition to the advancement of learning. He recognized that scientists set apart by themselves might come to devote their energies to the pursuit of abstractions or spend their time in satisfying idle curiosity, yet he fully realized the need for scientific detachment. To maintain this detachment and serve industry practically he strove to effect a balance which might be phrased as: Fundamental science pushing the adoption of scientific methods against the old rule-of-thumb; industry guiding scientific study into productive channels and checking preoccupation with abstractions. This was a valid balance 12 years ago, is today, and will be in the future.



Pouring experimental heat of cast iron from a 250-pound capacity electric furnace. Large-scale laboratory experiments require great amounts of molten metal



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

A. E. BUCHANAN, Jr.
Lehigh University

The Noisiest Room in the World

WHAT kind of a noise annoys an oyster? That's nonsense, of course, but noises—and noise insulation—are important, so a unique chamber has been built to study them. Here between four walls at the Johns-Manville Research Laboratories is enough distortion and magnifying of noise

Looking into the noisiest room in the world; loudspeaker at upper right

to drive a person insane in half a day. All the worst features making for noise have been combined into an architect's nightmare. The walls are hard, reflecting surfaces, set at angles to one another. The floor throws back any sound. The roof is set at a tilt. In the center of the room is a loud speaker mounted on a pendulum which swings back and forth distributing the noise evenly into all parts of the room.

In the ordinary room, as we all know, a sound dies away almost immediately. Here each sound lasts for 12 seconds; hundreds of sound waves may be set whizzing from wall to wall in those 12 seconds. It is possible for one man with a wide voice range to sing all four parts of a song at once—a one-man quartet. A musician recently played "Home Sweet Home" in all four parts on a trombone in this chamber.

On the wall behind is hung a sample of Johns-Manville sound-absorbing rock wool material, being tested for its efficiency in lowering noise. This is the most effective method of lessening noise, after accoustics have been adjusted. In the silent chamber at Johns-Manville, a direct contrast to this room, one has the impression of being suspended in air. A blind man was led into this silent chamber and, his ear trained to sense the presence of walls, he drew back in fear, thinking he was walking off into space.

"But I Only Had One Drink"

AN analysis of 119 automobile accidents, involving the death of 216 persons, made in Milwaukee by Herman A. Heise, M.D., and published in the *Journal of the American Medical Association* (Chicago) shows that it is not primarily the obvious "drunk" who constitutes a major road menace, but the "drinking driver"—the man who thinks he can drive as well (or "even better") after a little nip.

Dr. Heise found that the alcohol accidents, mostly after little nips, were responsible for injury or death to more than two people per accident, while the non-alcohol accidents involved only slightly more than one person per accident. There is a direct relationship between the severity of the accident and the amount of alcohol; from which the only-one-little-nipper may draw the conclusion that he is relatively unlikely to kill anyone, but may merely maim someone for life. This knowledge should be a relief.

"Considering a person sober as long as he can still walk and talk is responsible for the small value of present day statistics regarding the relationship of alcohol to automobile accidents," Dr. Heise states.

Rubber Wrapping

CELLOPHANE has a new rival. This is Pliofilm, a new rubber product made by Goodyear. It is produced synthetically from rubber by an entirely new process.

Pliofilm has the advantage of being moisture-proof after considerable wrinkling or creasing. In this it is unique among wrapping materials. It is also claimed to have greater tear-resistance but, strangely enough, it does not have the elasticity one associates with ordinary rubber. It does have a toughness with some "give."

Another very important advantage of Pliofilm is its heat-sealing quality. A moderate amount of heat with pressure makes possible a strong permanent seal of the edges.

Wood Briquettes

EVER since man has been conscious of waste and inefficiency, the saw mill industry has been perplexed by the problem of what to do with the sawdust and mill waste.

This problem was solved temporarily for some by the building of sawmills in or near towns large enough to enable them to sell this mill waste to industrial plants or buildings for use as fuel. This method was only successful for a few mills as the centers of population are not, in most cases, near enough to make this feasible and as the forests are being cleared off farther and farther back, it became increasingly difficult. Sawdust piles grew larger and larger and lay as monuments to an age of waste and devastation.

This problem beset Mr. Robert Bowling, Chief Engineer for Potlatch Forests, Inc.,

An end view of the machine in which wood briquettes are made from waste

and was solved, as are most problems, by combining a few old ideas with a new application.

The larger sizes of dry mill waste first go through a "hog," a machine for breaking down the scraps into small fibers, and from there it is taken to the briquetting department to be made into a solid fuel. In the briquetting department the fine wood fibers and sawdust are compressed under enormous pressure without the use of any binder, into a cylindrical unit of fuel about four inches in diameter and 12½ inches long. The briquettes are so compact that they will not even float in water. They may be started with a match and because of their density, burn in a manner comparable to coal and leave almost no ash.

PROGRESS In This Age Of Science

As Told to SCIENTIFIC AMERICAN

By DAVID SARNOFF

President, Radio Corporation of America

THE business applications of radio facsimile transmission, which have been established by several years of successful operation of the transoceanic facsimile services, promise to be greatly extended by a high-speed radio facsimile service operating in the micro-wave band between cities in the United States. Our experimental accomplishments in this field justify the hope that we probably will have such a circuit operating between New York and Philadelphia within a year.

The higher speed we expect to obtain by transmission on ultra short waves should make it possible to send exact reproductions of written pages instantaneously between cities. This may revolutionize our ideas of telegraphy, based on dots and dashes of the Morse code. The business man may, within a few years, be flashing letters by radio over his signature.

This would seem to be a logical development of the transoceanic radio facsimile service, operating on longer waves. That service has made readers in the United States familiar with the appearance of photographs in their newspapers depicting events in Europe a few hours after they occur. It has already enabled business houses to transmit by radio across the Atlantic reproductions of engineering designs, legal documents, fashion drawings, and similar material.

New 1000-Watt 16-mm. Movie Projector

THE new Filmo 16-millimeter 1000-watt projector threw 15- by 20-foot pictures of absolutely theater brilliance in a recent showing in a big Chicago theater auditorium. The theater, which has no balconies, seats 1400 people, and the finest details of the pictures were perfectly clear from the rear seats. The throw was 110 feet, and a two-inch lens (regular equipment with the projector) was used. The brilliant quality of screen result was unanimously conceded by all observers, it is stated.

The manager of the theater, who was present, stated that he could see little if any difference between the 16 millimeter projection and that which he ordinarily secures from a 35 millimeter arc projector run from the same booth where the 1000-watt projector was temporarily ensconced.

Tilting for Resuscitation

PROFESSOR Yandell Henderson of Yale, a physiologist and noted authority on the biochemistry of respiration, in a recent report to the American Medical Association, described a new development for resuscitation called the tilting board. "This device," he states, "is in principle a seesaw on which the victim is laid and rocked slowly through an angle of 30 degrees or more from the horizontal each way. Adjustable pegs are placed in holes in the board at the shoulders and feet to keep the body from sliding. When the head is lowered and the feet are raised, the weight of the abdominal viscera acts on the diaphragm to induce expiration. When the head is raised, the movement of the viscera and diaphragm feetward induces inspiration. If the body is completely flaccid, the victim should be laid on his face, so that the tongue will fall forward; otherwise on his back. The device is quite easily constructed by any carpenter and would probably prove useful at bathing places and in the accident rooms of hospitals. It is particularly adapted to use by laymen."

Artificial respiration applied with a tilting table

Photo Cells Time Races Accurately

GREYHOUNDS winning races are now automatically timed by photoelectric cells which eliminate the possibility of errors. The time which it has taken the winner to cover the racing distance is instantly recorded in fifths of a second on a five-foot illuminated motor driven clock located conspicuously before the grandstand. The time which is recorded on the clock cannot be contested since it is entirely automatic, starting itself with the release of the greyhounds and stopping only when the winning greyhound crosses the finish line.

The light sources are mounted on a galvanized iron pipe firmly fixed in concrete and located at one end of the finish line directly opposite the judges' stand. The photo-cells are similarly mounted and located on the other end of the finish line immediately in front of the judges' stand. Two beams of light are used, one above the other, coinciding with the finish line of the race track. The use of two beams of light insures the positive operation of the control, for if a winner should happen to be leaping at the finish line, he is certain to intercept either the upper or lower beam. The control functions equally as well in daylight as it does under artificial light at night. In order to allow the mechanical rabbit to clear the timing device, the lower light beam is adjusted to throw its beam just above the rabbit and parallel to the track surface.

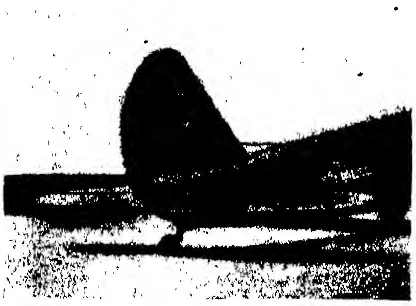
AERONAUTICS IN 1934

By PROF. ALEXANDER KLEMIN

[Some of the items mentioned in this review have been published in past issues of SCIENTIFIC AMERICAN. *Brief notice must be given to them, however, in order to present a complete picture of the aviation industry during the last year.*—The Editor.]

AS befits an industry which has passed through adolescence, aviation now advances with refinement and evolution as the watchwords, rather than startling innovation. Aeronautical achievements in 1934 have therefore been not quite so spectacular as in previous years, but they have been valuable, they have embraced every phase of the art, and they have shown an undiminished drive towards progress.

AERODYNAMIC RESEARCH. It is a mistaken idea that aerodynamic research is conducted solely in the laboratories. Such research is also carried on in the most practical fashion by the leading aircraft constructors, and there is constant co-operation between the design engineers and the laboratory men. Thus "trimmers" which have recently undergone investigation in the laboratories were initially a drawing office product. A "trimmer" is a small auxiliary or servo surface placed at the rear end of a principal control surface—rudder,

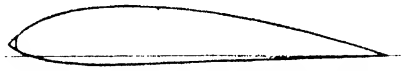


"Trimmer" or servo surfaces placed in large airplane control surfaces

elevator, or aileron. Trimmers, placed on the rudders of twin engined ships, allow a turning couple to be introduced, without heavy muscular effort by the pilot, which will keep the plane on its path when one engine is out of commission. Trimmers are now being used with equal success on the elevator; by displacing the trimmer a few degrees and in turn displacing the freely mounted elevator, it is possible to "trim" or "balance" passenger airplanes without the use of the adjustable stabilizer. Dispensing with the adjustable stabilizer means decrease in structural complication and an increase in aerodynamic efficiency. Trimmers used on the ailerons have been found useful in correcting wing heaviness.

Experimentation in the use of filleting has been proceeding steadily; by the use of such fillets between the fuselage and the wing it is now possible to avoid all the loss of lift and efficiency which were previously present owing to the mutual interference of wing and body.

Boundary layer experiments by the N.A.C.A. have been partially disclosed; there seems to be little doubt that by suitable ejection of air under pressure through slots in the wing the profile drag can be reduced and the maximum lift increased—with negligible power expended in the blower system. Foreseeing the time when airplanes may fly at nearly the speed of sound, the N.A.C.A. is constructing a high-speed wind tunnel in which airfoils will be tested at between 400 to 500 miles per hour. The first problem will be to develop sharp-edged airfoils to replace the round-edged airfoils of to-day, which are perfectly efficient at



Sharp edged airfoils become efficient when used at high air speeds

moderate speeds, but lose lift and efficiency at very high air speeds. At such high speeds the air becomes "compressible" with a wave formation similar to that of sound waves. While no radically new lift increase devices have appeared, the allied problem of lateral control when a lift increasing flap extends along the whole span is now approaching solution.

A very interesting aspect of aerodynamics is its growing influence on other branches of engineering, as in streamline trains, streamline automobiles and the design of the America's Cup challenger.

TRANSPORT PLANES. The transport airplane has again increased its top speed and cruising speed—there is apparently no end to progress in this direction. In safety, speed, and passenger comfort there is not the slightest doubt that American airliners now surpass the best designs of every other country. Proof of this assertion lies in the fact that German interests have purchased Douglas transports, and that the skilful designer and hard-headed business man Anthony H. G. Fokker has acquired a license to build these ships in Holland. The Douglas transport now in regular service on the T.W.A. lines has achieved a world-wide reputation from its very first public flights. Without prejudice to the merits of other fine ships, the Douglas DC-2 may be recorded as a supreme American achievement in transport plane design.

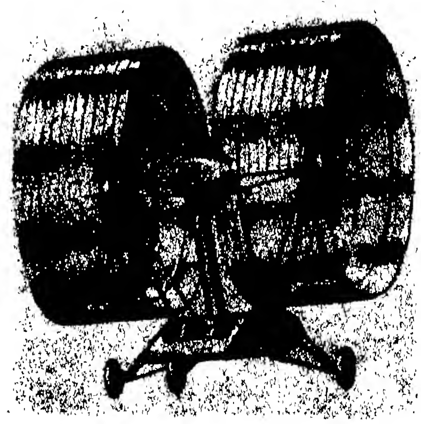
Before construction was started on the Douglas DC-1, hundreds of wind tunnel and structural tests were made in addition to an intensive mock-up investigation. Studies were made of special items such as fuel systems, control mechanisms, heating, lighting, and ventilating systems, and sound control. The finished airplane was flight tested for over 200 hours, and 15,000 gallons of fuel were used in these flight tests. The development cost of the first airplane was approximately 325,000 dollars.

The supremacy of the American airliner in performance, structure, and passenger accommodation is thus seen to be based on intense research and effort rather than on brilliant and unsystematic design.

Another worthwhile achievement in the transport airliner lies in the realization of airplane sleepers. Credit for the first use of sleepers goes to the Curtiss-Wright Condor, which now gives regular sleeper service on American Airways between Dallas and Los Angeles, and on Eastern Air between New York City and Miami. Day and night accommodations are equal if not superior to those of a Pullman car.

AIR RACES. The annual National Air Races held at Cleveland during the Labor Day week end were concentrated into four days instead of the usual ten. This concentration of events, perfect efficiency and timing in the various races, and such innovations as the "horse-race" start resulted in enhanced public interest and attendance, with a record crowd of approximately ninety thousand spectators on the last day. But if the Air Races were a popular success, they were not productive of much technical novelty. The builders of racing craft had contented themselves merely with crowding more and more power into their planes. This "super-power" together with the short laps and the consequent sharp turns 'round pylons in the famous Thompson Trophy race led to a dangerous increase in the centrifugal forces acting on the wings of the racers, and the death of "Doug" Davis. No former speed records were broken. While future races may be just as interesting as ever to the public, some modification of racing rules may be necessary if the races are again to foster engineering progress in aviation.

ROTARY AIRCRAFT. During 1934 great excitement was aroused by the announcement by several workers, American and European, of the "paddle wheel" type of aircraft. In this type of aircraft, airfoils placed at the ends of long arms rotate about a horizontal axis which is at right angles to the line of flight. While the "paddle wheel" aircraft gives promise of powerful vertical lift, some doubt has been aroused by wind tunnel tests as regards its efficiency in forward flight. In Belgium the Florine helicopter, equipped with two lifting airscrews so disposed as to eliminate turning couples (although rotating in the same direction), has made a number of successful though limited flights. The Autogiro has now been successfully flown with the fixed wing eliminated, two blades instead of the former four or three,



A drawing of one type of "paddle wheel" aircraft which holds promise

with control by suitable displacement of the vertical shaft about which the lifting blades rotate. As a result of these innovations the Autogiro has improved considerably both in efficiency and control. While production of the Autogiro on anything but an experimental scale has ceased, its advocates are working as energetically and hopefully as ever on experimental types. It is interesting to note that during the year both the Auto-

giro system and the Wilford Gyro-plane have been tried out for the propulsion of boats without application of engine power —that is, to replace the usual sail.

PLANES FOR PRIVATE FLYING. Eugene L. Vidal, Director of Aeronautics, in the Department of Commerce, startled the aviation fraternity by announcing a plan for a 700-dollar "flivver" airplane of wonderful characteristics. Mr. Vidal's first announcement was received with justifiable criticisms but was followed later on in the year by a much more practical step. The Department called for bids on 25 small inexpensive two-seater airplanes for use by its inspectors, with requirements specially directed to the needs of the private flier. The most important of these requirements were a landing speed of 35 miles per hour and a top speed of at least 110; an engine under 100 horsepower; side-by-side-seating and perfect vision; exceptionally short take-off and landing run; and ability to land safely without levelling out. The last feature would be of course a great boon to the "dub" pilot. Bids were opened in August with a great variety of designs and a wide range in price. While no decision has as yet been announced as to the winner of this competition, study of such designs as have been made public indicate the following advances in the low plane field:

1. The speed range of 110 to 35 miles per hour can be met by non-freakish, sound designs, equipped with suitable lift increase devices.

2. The gap between the "ideal" flying machine and the realizable airplane has been greatly narrowed.

3. All metal construction, including monocoque fuselage, is possible in the moderately priced plane.

4. An airplane is possible which will be easily controlled under almost any condition of flight.

5. Planes that can be used in small fields are within our reach.

6. Something around 3000 dollars is a much more likely price for the "ideal" private plane than 700.

Of course these characteristics of the competing ships exist only on paper. But the regular designs of the year in low and moderately priced cabin planes have been most encouraging. All metal construction; absence of vibration; vision front, down, rear, and up; flaps to act as air brakes; high speeds and low fuel consumption, make private flying this year much more enjoyable and safe than ever before in the history of aviation.

Strange to say, the greatest novelty in the moderate power field was not featured in the Department of Commerce competition. We are referring to the Crouch-Bolas Dragonfly. In this comparatively small machine two air-cooled engines of moderate power are placed rather far out on the lower wing of the biplane. The engines swing oversize propellers whose slipstream embraces a large proportion of both the upper and lower wing. By skilful utilization of the slipstream on wings provided with slots and flaps, excellent results are achieved in quick landing and take-off and climb at a steep angle.

GIANT SEAPLANES. Lindbergh's valuable report on transatlantic service submitted to Pan American Airways, and the wonderful success of the Sikorsky *Brazilian Clipper* have brought the day of seaplane services to Europe appreciably closer. The construction of a larger seaplane terminal in the Bermudas will also be helpful. The Sikorsky S-42 is a four-engined, all metal, high-wing monoplane flying boat. With a gross weight of 19 tons, and a cruising speed of well over 150 miles per hour, the new clipper is the largest flying boat built for regular transport service. With 32 passengers, a crew of five, and 1000 pounds of mail and express, its range exceeds 1200 miles.

Full confidence may be felt that the *Brazilian Clipper* (which has already been fully described in our columns) is only the forerunner of larger, faster seaplanes which will eventually evolve into a commercially practical aircraft for non-stop service to Europe.

POWER PLANTS. In aircraft power plants there has been steady advance but no extraordinary changes—no aircraft Diesels, no gas turbines, no new cycles of operation have appeared on the horizon.

The air-cooled engine remains just as popular as ever, and since reduction of its drag remains a vital problem, two improvements in cowling are very welcome.

One improvement is in the Watter Tunnel Cowl. There are also the Townend ring and the N.A.C.A. cowl. Of these three types of cowling, the Townend consists of a wide metal ring placed around the engine just outside the cylinder heads. It is the simplest but also the least effective of the three types.

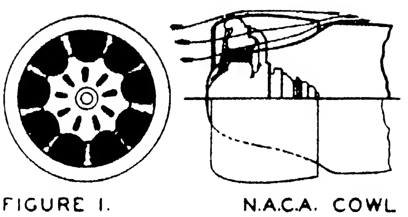


FIGURE 1. N.A.C.A. COWL

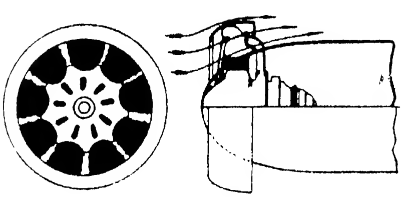


FIGURE 2. TOWNEND RING

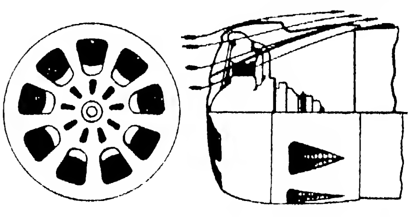


FIGURE 3. WATTER TUNNEL COWL

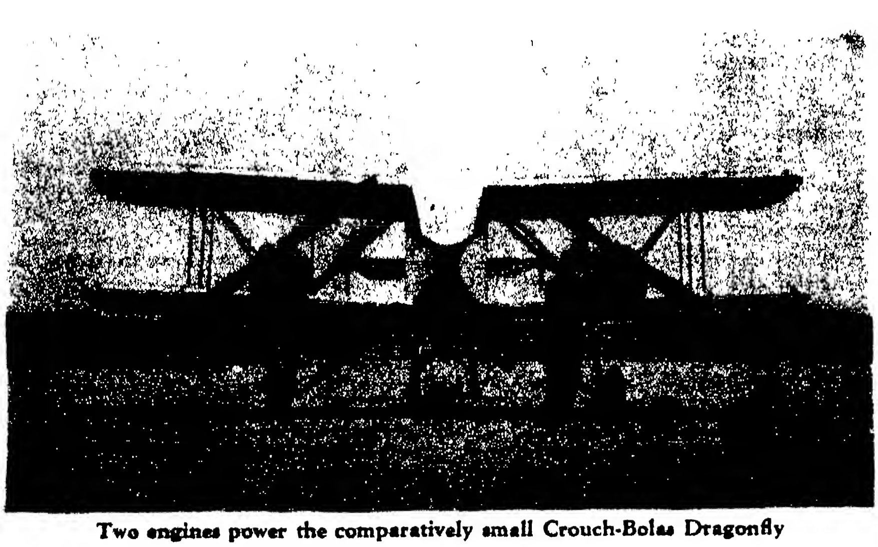
Courtesy *Aero Digest*

The three types of engine cowlings discussed in the text on this page

The N.A.C.A. cowl provides somewhat better guidance of airflow than the Townend, and diminishes the turbulence somewhat more. But it still leaves inter-cylinder interferences, does not prevent turbulence in back of the cylinders, and gives the air only two dimensional guidance.

In the case of the Watter Tunnel Cowl, the engine is completely enclosed within a streamline form and only a definite quantity of air is admitted through the main front openings to each of the cylinders. Once the air enters the opening it is guided around the cylinders by means of individual tunnels, the restriction being complete in three directions. The distance between the walls of the tunnel widens to its maximum at the cylinder and then converges to terminate in a point, the walls and side being cut out to form a triangular opening for exhausting the cooling air. Tests in Mexico on a Vought Corsair have shown not only excellent aerodynamic qualities, but also the best possible cooling for the engine. Tunnel air guidance has thus been shown of distinct value.

While the engine itself has apparently undergone no radical changes, higher speeds of revolution, higher compression ratios, better fuels, are resulting in a continuous increase in engine power *without* a corresponding increase in weight. Supercharging, both ground boost and altitude power maintenance, are making constant progress. With transport airplanes reaching an apparent limit in aerodynamic refinement, it is remarkable what increases in performance have been achieved during the year by improvement in the power plant and the propeller. For example, the Boeing 247 began the year with a cruising speed of 165 miles per hour. Without other changes the employment of a controllable pitch propeller raised the cruising speed to 171 miles. With the use of slightly more supercharged and geared down Wasp engines of 550 horsepower, there was an additional pick up of 14 miles in the cruising speed.



Two engines power the comparatively small Crouch-Bolas Dragonfly

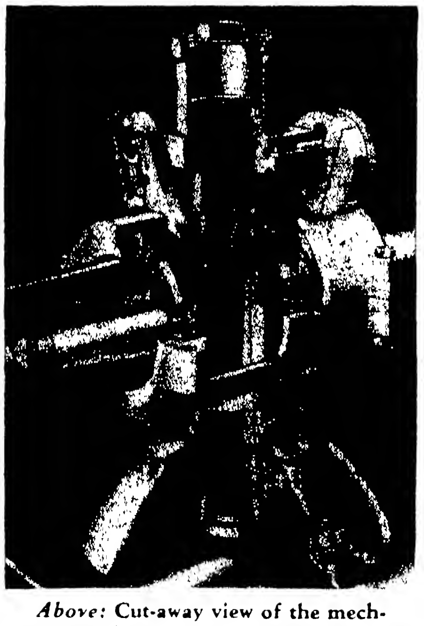
Aeronautics in 1934

(Continued)

One of the outstanding engine accomplishments of the year lies, however, not in increased performance but in the introduction of completely automatic lubrication of the valves and valve actuating mechanisms of the new Wasp engine by the standard engine oil supply system. Formerly this was a manual operation; now manual labor, grease guns, etc., are eliminated and maintenance costs are reduced accordingly.

NEW DEVICES. One of the extraordinary things about aviation lies in the way in which it fosters ingenious auxiliary devices, drawing on almost every other industry. The list of new devices achieved in the last year is too long for mention of them all. We will review but a few of the most promising ones.

Controllable pitch propellers have come into greater and greater favor, and almost every important commercial or military plane is now so equipped. The controllable pitch propellers which have already passed into current service are: The Hamilton Standard, which has but two settings and is



***Above:* Cut-away view of the mechanism of a two-setting variable pitch propeller. *Right:* The same type of propeller installed in a plane**

operated hydraulically; the Curtiss which has an unlimited pitch range and is actuated by an electric motor with powerful speed reduction; and the Smith, mechanically operated and also with unlimited pitch setting. These types are all actuated at will by the pilot.

The past year has seen active and successful work on two types of automatic propellers—designed to relieve the busy pilot of at least one burden. Thus the Squires propeller (which has a pitch range of 8 to 10 degrees) is automatically actuated by centrifugal force on counterweights connected with the blades and properly balanced against adjustable spring pressures. The Eclipse automatic propeller has limited adjustment and is actuated by proper balancing of the propeller thrust and centrifugal torque forces against adjustable spring pressures placed at the front of the hub sleeve. At take-off, with high thrust and slow speed, the pitch is lowered automatically. At high speed and lower thrust the spring action induces higher pitch.

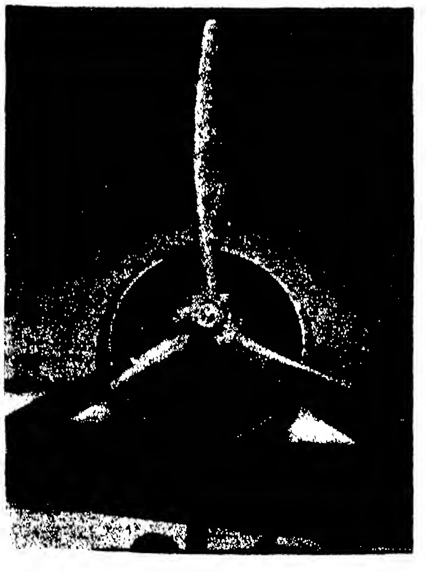
As to the improvement in performance possible with the manually operated variable pitch propeller, the following figures have now been definitely established: rate of climb 15 to 20 percent better; service ceiling raised 15 to 20 percent; take-off run reduced 20 to 35 percent. Flight on one engine in a twin-engine plane has also been established beyond all question, and largely by the use of controllable pitch.

An invention which aroused the keenest interest was the "fog dispeller" developed by the Massachusetts Institute of Technology. When nozzles fitted into a pipe 300 feet long began pouring a secret chemical into a rolling fog, buildings 2000 feet away and previously invisible stood clearly revealed against a background of white vapor. The chemical appears to have the ability to collect and condense water vapor in the air, and to precipitate it to the ground in a raindrop form.

Another important development has been in the application of the Link trainer to blind flying. A cockpit with rudimentary wing and tail surfaces is mounted universally on a pivot. A hidden pneumatic mechanism simulates the movements of the airplane in the air by the operation of a normal stick and rudder bar. Covering in of the cockpit and mounting of special instruments enables this type of "hangar flying" to train men quickly and efficiently for blind flying.

There have been numberless improvements in such accessories as the automatic pilot, electric tachometers, navigational computers, radio shielding, camera guns, and so on.

FLYING IN THE STRATOSPHERE. One of the most significant trends of the time is the growing interest in stratosphere flying. Wiley Post, of 'round the world flight fame, made an earnest attempt in his Lockheed Vega *Winnie Mae*, powered with



a Pratt and Whitney Wasp, to beat the world's airplane altitude record of 47,352 feet. Mr. Post, for reasons which have not been made public, abandoned his efforts for the time being—in spite of some successful preliminary trials. Great interest attaches nevertheless to the special equipment which was developed at his instigation. His Wasp

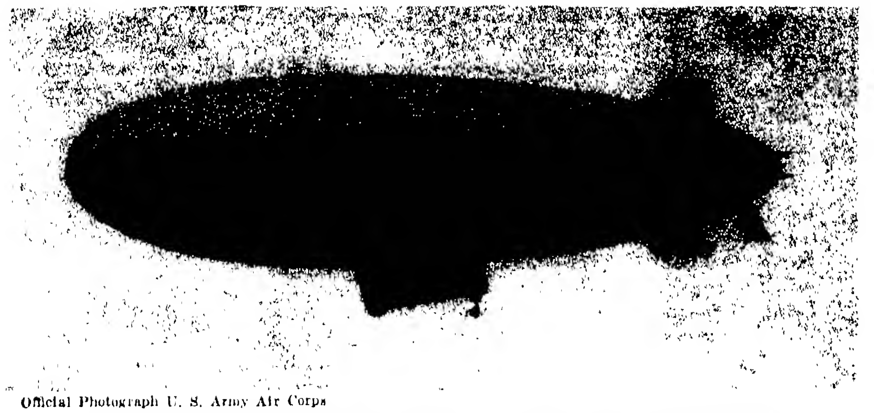
The Link trainer for blind flying, described in the column at the left

engine had a sea level rating of 450 horsepower and this was to be maintained absolutely up to an altitude of 30,000 feet, bringing up the speed of the *Winnie Mae* to 275 miles per hour. The use of two superchargers in series, with an intermediate cooler attracted wide attention. Not only the engine but the pilot himself was to be "supercharged." Mr. Post actually tried out an air-tight metal helmet and a rubberized silk suit. Air was drawn from the first supercharger into the helmet and exhausted through the boots. A mixing valve and air heated by the exhaust, allowed efficient temperature control.

Wiley Post's attempt has a special importance because it is most certainly the forerunner of the transportation of passengers in the stratosphere, with superchargers in series, airplanes with sealed cabins, airtight ignition and carbureter systems and other obvious devices.

AIR TRANSPORT. In spite of the injuries which governmental policies have caused American air transport, this industry has made progress in a number of ways. The Air Express Division of the Railway Express Agency has arranged an air-express service to Central and South America, linking up the vast airline network in the United States with the Pan American Airways. The Railway Express air system has now reached a mileage of 15,500 serving 110 cities throughout the country. Tonnage has increased by about 150 percent over the previous year, individual shipments are growing in size, and the commodities handled are of an ever greater variety—with motion picture films, advertising materials, art work, flowers, jewelry, spare machine parts, reports, legal papers, and so on, leading the list.

The cancellation of airmail contracts early in the spring of 1934 was disconcerting. But during the month of July the last of the contracts under the revised set-up was awarded, and the system is again in full operation over all the airways. According to the latest figures of the Post Office Department the national system now covers 28,548 miles with daily scheduled flights totaling 78,198 miles. The system mileage has thus increased by some 3000 miles over the pre-cancellation figures, but scheduled flights have unfortunately been cut by nearly 20,000 miles daily, with service over a majority of the old routes radically reduced —for example between New York and Chi-



Official Photograph U. S. Army Air Corps

The *TC-13*, largest non-rigid airship ever made in the United States

cago service has been cut to a schedule of three trips daily instead of the former six. Reductions in compensation per mile have also been very severe, and the carriers' revenues have suffered drastically, with the transport companies losing money heavily as a result. The Interstate Commerce Commission has now organized a Bureau of Air Mail, and the fate of the industry now rests with I.C.C. and the Federal Aviation Commission.

An offset to the bleakness of the picture lies in the greater speed and growing effectiveness of the Pan American services between the two Americas and also in the granting of airmail contracts for service in the Hawaiian Islands.

No review of American air transport, however brief, can be made without mention of the accident report of the Department of Commerce for scheduled operation in the first half of 1934. During this period the lines flew 796,950 miles per accident, there being 27 accidents in 21,517,658 miles of flying. In six accidents passengers or employees of the lines were fatally injured. In the 27 accidents 179 persons were involved and of these 106 suffered no injury whatsoever. There were 34 minor, 10 severe injuries and 29 fatalities. Contrary to public opinion, *not* every airplane accident is fatal. (In the January—June 1933 period the miles flown per accident were only 538,794 although there were fewer fatalities.) Analysis of the 27 accidents showed the following percentages: Personnel errors, 52.04%; power plant failures, 11.85; airplane failures, 18.51; weather, 14.82; airport and terrain, 0.93; other causes, 1.85. While safety is growing, it is seen that even better personnel is the vital need.

LIGHTER-THAN-AIR. In the sphere of the large rigid airship, the year has been uneventful. The *Macon* has been conservatively handled by the Navy, with no spectacular achievements to its credit. There is at the moment but one large rigid airship in process of construction—the *LZ 129'* at Friedrichshafen, Germany. In spite of Dr. Eckener's energy, completion of this ship has been further delayed. At the same time the depressing effects of the *Akron* disaster are disappearing and the proponents of the large airship are recovering courage. A number of bills to encourage transatlantic airship service have been discussed in Congress. General William Mitchell has advocated before the Federal Aviation Commission the construction of 50 large ships for use with the Navy. Dr. Eckener, encouraged by the continued success of his intermittent services across the South Atlantic to Brazil, has submitted to the same Commission a plan for a regular North American German airship passenger service with two German and two American craft to be put into service. It would appear that airship men still have not lost hope of putting large dirigibles into oceanic service ahead of the large seaplanes.

In the non-rigid airship field there is more interesting matter to report. The Army Air Corps has received from the Mercury Aircraft Corporation the *TC-13*, the largest nonrigid airship ever built in the United States, with a volume of 360,000 cubic feet and an over-all length of 233 feet. With a special landing gear of the airplane type this airship can utilize the dynamic lift of its hull, as distinct from the bouyancy of its gas, and take off with considerable overload. With use of dynamic lift the useful load is increased from 6117 to 8500 pounds. A most interesting experiment has also been made in anchorage at sea of the *TC-13* for some 75 hours, with a drag cone of large diameter connected to the airship by means of 800 feet of anchor cable.

AVIATION AND THE GOVERNMENT. American aviation has always been blessed or cursed with innumerable investigations or commissions. This year has proved no exception. The cancellation of the airmail contracts (whether justified or not) dealt a terrible blow to air transport. When the Army Air Corps took over the flying of the mails and a number of splendid young pilots were killed, the public was terribly shocked. Thereafter, as our readers will remember, came the Baker Committee, with Newton D. Baker as its chairman. Unkind critics stated that this Committee was called into being to whitewash the Army, and Colonel Lindbergh firmly refused to become one of its members. The Baker Committee's careful report led to the creation of a general headquarters air force which placed the control of every combat flying unit directly under the office of the Chief of Staff, and destroyed the authority of the Chief of Air Corps. Perhaps this was a rebuke to Major General Benjamin D. Foulois who undertook the task of carrying mail at a moment's notice—but what could a soldier do but execute a Presidential command? The feeling is that Mr. Baker's Committee helped Army air work, but it did little for American aviation as a whole.

Now the Baker Committee has been followed by a much more important body, the Federal Aviation Commission, with Clark Howell, the Atlanta publisher, as chairman; E. P. Warner and J. C. Hunsaker as the aeronautical members; and Franklin Lane and Albert J. Berres as the two remaining members, with Carroll Cone as executive secretary.

The Federal Aviation Commission will have the advantage in its comprehensive hearings of listening to the testimony of the most representative and well informed men in American aviation. It needs to be well informed since it has the formidable task of recommending to Congress legislation to stabilize the entire industry and to formulate a comprehensive five or even ten year program for the nation's defense in the air.

Here are some of the important questions which the board will have to decide:

Should we have a united air service? (As in Great Britain). General William Mitchell remains as strong an exponent of this idea as ever, and is opposed, among others, by Admiral Ernest J. King of the Navy Bureau of Aeronautics, who insists on the special duties and training required by the Naval Air Service.

Army and Navy procurement of planes and engines is another thorny matter. To buy planes by private treaty, or with limited competition, seems contrary to the spirit of American institutions; on the other hand how are public bids open to all to be reconciled with adequate reward for the designer or builder of proprietary aircraft of outstanding merit?

Our air transport surpasses that of every other country. But how can it continue to thrive on totally inadequate rates of pay for carrying mail? How can the operators plan any long-term policies with short-term contracts and fierce competitive bidding at frequent intervals?

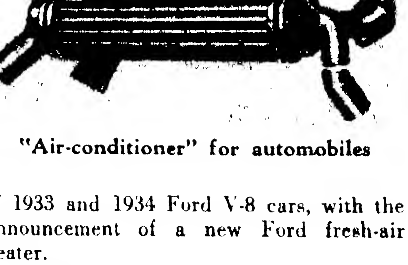
Our aeronautical research is well to the forefront, but how much duplication of effort and waste of money are to be feared in view of the many governmental agencies engaged in such research?

The universities and colleges engaged in aeronautics are doing splendid work, but find that the National Advisory Committee for Aeronautics is tending to a monopoly in scientific effort. Should not these universities be allowed to collaborate with the N.A.C.A. and be allotted research funds commensurate with their abilities and facilities?

The entire future of American aeronautics is dependent on the work and findings of the Commission.

Motor Car "Air Conditioning"

AIR conditioning, the newest wrinkle in motor car heating, is being made available by the Ford Motor Company to owners



"Air-conditioner" for automobiles

of 1933 and 1934 Ford V-8 cars, with the announcement of a new Ford fresh-air heater.

Comfortable driving, even in the coldest winter weather—with an adequate supply of fresh heated air changed every two minutes—is made possible with the new heater,

Two New Uses for Photo Cells: *Above:* The human eye is not sensitive enough to detect the slight gradations of color as a steel bar is heated and goes from red hot to white heat. Therefore, (*Continued above*) where it is necessary to determine the exact temperature of metal, photo cells may be used. In the illustration, two cells in tubes near the top of the photograph cut off the electric heating current when the steel bars below them reach the proper temperature for finishing. *Below:* Studying sewage turbidity with the Westinghouse Transometer. The sample is placed between a light source and the photo cell, the amount of transmitted light being indicated on an instrument dial in terms of relative turbidity

the announcement said. The warm air supply is as clean, wholesome, and odorless as that used for air conditioning the modern home.

The new heater is built just like a boiler, with 24 flues, each 13 inches in length, providing almost 500 square inches of heat radiating surface. The unit is a rigid, integral part of the engine exhaust line. The extremely hot exhaust gases from the engine are passed through the flue tubes. Fresh air forced through the heater by the fan is blown around the outside of these tubes, instantly heated and passed on into the car.

The heat register is installed in the right dash wall, in front of the front-seat passenger. The heat supply may be regulated or may be shut off completely by a button controlling a valve in the intake pipe, which may be operated by the foot. The heat supply also can be directed to any part of the front compartment. Provision is made for the installation of a second heat register in the floor of the tonneau if desired.

Bad Medicine

CYANIDE is one of the quickest and deadliest poisons known to man, but, believe it or not, the doctors have discovered that they can inject it into the bloodstream of a patient in order to study the action of his heart. According to the *Technology Review*, "when the medico is examining a heart and wishes to know how long it takes for the blood to circulate through a certain part of its course, he injects a minute quantity of very dilute cyanide solution into the patient's foot. Then he sits by the bedside with watch in hand. The cyanide is carried along in the blood stream. When it reaches a certain organ, it produces a momentary paralysis of the respiratory centers, and the patient gasps. In the case of an extremely inefficient heart, the elapsed time between the injection and the gasp may be as much as 90 seconds.

"Claude Bernard, the founder of experimental medicine, showed long ago that a very small quantity of cyanide if taken into the body passes through it unchanged. The cyanide does not react chemically with anything in the body but apparently poisons by being present. It perhaps affects the catalysts or enzymes which exist in the body and upon which the maintenance and coordination of bodily functions evidently depend. A simple experiment illustrates the action of cyanide upon a catalyst. If a small amount of spongy platinum is added to a solution of hydrogen peroxide in water, the liquid previously tranquil commences to effervesce vigorously with the evolution of oxygen from the decomposition of the peroxide. A few drops of cyanide solution stop the effervescence at once by poisoning the catalyst and stopping the catalytic action of the platinum.

"Cyanide kills quickly in such short time that it seems impossible for the poison to have diffused from the place where it entered the body to the place where its action would be effective. Cyanide combines readily with oxygen and with sulfur to form non-poisonous cyanate and thiocyanate. These substances are naturally present in the body, thiocyanate in the saliva and cyanate in the blood and urine. The hypothesis has been put forward that cyanide introduced into the body reaches a nerve fiber and takes the sulfur away from the thiocyanate which exists in the tip of the nerve, leaving cyanide in the nerve and itself being converted into inert thiocyanate, that the cyanide now present in the nerve acts upon the thiocyanate in the next portion of nerve fiber, in such manner that cyanide at one end of the nerve produces cyanide at the other almost instantaneously by a process similar to electrostatic induction without the transfer of actual substance.

"We have read an account of an experiment in support of the hypothesis," says *Technology Review*, editorially. "A dog was fastened securely in a two-bladed guillotine, a dose of cyanide was placed on his tongue, and as soon as possible thereafter the knives of the guillotine were made to fall. The dog's head and tail were cut off simultaneously—and cyanide was detected by chemical tests on the tail. This is a tall story, we admit. We haven't seen the experiment, and we'll believe it when we do see it."—*A. E. B.*

"GAS" AND OIL TAXES

THE Federal Government derived approximately 18 percent more revenue from gasoline, lubricating oil, and pipe line taxes the first seven months of 1934 than it obtained during the same period in 1933, according to figures issued by the United States Bureau of Internal Revenue.

Power Direct from Sunlight

A SMALL electric motor, powered solely from sunlight and which will run continuously as long as the rays of the sun fall on the light-sensitive surface, has recently been constructed by a Detroit manufacturer and experimenter, J. Thos. Rhamstine. A battery of 20 small light-sensitive and power generating disks, connected together and directly to a small direct current permanent-field motor, turns the motor at a high rate of speed without the use of any source other than the effect of the sun's light rays on the disks.

As long ago as 1877, work was done in Germany with copper-oxide cells, and several years ago Lange made a rotating motor in that country, using similar cells. But what is asserted to be the greatest advance in the science of generating electricity directly from light has recently been done, and with an entirely different type of cell. The cells used in Rhamstine's motor are of a different type from those of Lange and, so far as has been determined, they will retain their generating power indefinitely.

This motor at present has no practical value, for the amount of power produced is very small. But to the scientifically minded, it has significance, since the possibilities of obtaining power directly from the sun have

A motor that derives power from sunlight; and its light-sensitive cells

scarcely been touched and in the future, as this science is further developed, more and more power doubtless will be obtained in this way. Some feel that it will in time become the chief source of power for our daily requirements.

South American Indians Chew Tooth-Blackening Plants

GLEAMING teeth are prized among certain Indian tribes of northern South America—but they gleam like jet rather than like pearl. The strange custom of chewing plants that blacken the teeth, in the belief that they are thereby insured against decay, has been reported to the Washington Academy of Sciences by W. Andrew Archer, plant explorer for the United States Department of Agriculture.

The Smithsonian Institution has specimens of two of these tooth-blackening plants, from different parts of northern South America. One of them, collected by Mr. Archer himself, has been identified by Paul C. Standley of the Field Museum of Natural History as a species hitherto unknown to science.

Whether or not the Indians are justified in their belief in tooth-preservation by these discoloring plants has not yet been determined, although ancient skulls with black and well-preserved teeth are reported from Peru. While there is no likelihood that white men will ever use these plans in dentifrices, their study may possibly shed some light on the problem of tooth decay. —*Science Service.*

Steel is Mural Motif

"BREAKFAST on the Hudson" might be the title of the attractive picture shown on this page but the scene is many miles from the big George Washington Bridge. Miss Dorothy Wilson and Royce M. Gallagher are having breakfast in the new "Steel Room" of the Union League Club in Chicago and the background is one of the Kaufmann and Fabry photograph murals which tell the story of steel from mine to finished bridges and buildings. The walls of the entire room are lined with these striking murals which help to make the interior one of the most distinctive club rooms in the country. The theme of steel is carried out in drapes, furniture, lighting fixtures, and carpet.

Striking photograph murals done in the modern manner, using steel as the motif

SHIP ELEVATOR

ELEVATORS in tall buildings for people, yes, but an elevator for a thousand-ton ship! It sounds impossible, but such an elevator is nearing completion at Niederfinow on the Oder River, in Germany. The structure will lift river steamers 120 feet in about 20 minutes and will make Berlin an ocean seaport. Including the great amount of water necessary, the actual weight lifted on each trip will be about 8,400,000 pounds. It is estimated that four 75 horsepower motors will operate it.

Research on Milk Bottle Caps

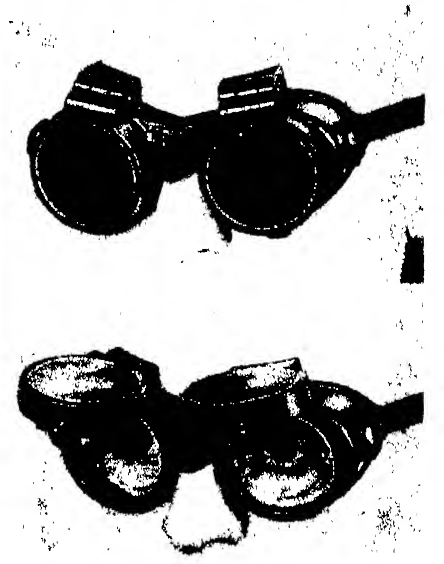
ONE hundred thousand pounds of paper are used daily to make milk bottle caps! Little wonder, therefore, that the cap manufacturers are wondering whether they can't improve on this time-honored closure. It has just been announced that the Toledo Bottle Cap Company has established an Industrial Fellowship at the Mellon Institute of Industrial Research, for research on paper milk bottle caps, bottle closures, and the study of improvements of paper packages for food and dairy products.

It is conservatively estimated that the annual retail distribution of fluid milk products in the United States requires about 12 billion paper caps of various styles. There are obviously many technical problems involved in such a program.

Director Weidlein of the Mellon Institute has appointed Marc Darrin to the incumbency of this fellowship. It is interesting to note that this fellowship has been established during the golden jubilee year of the glass milk bottle.—*A. E. B.*

Double Protection Industrial Goggles

MANY an eye has been injured or destroyed because workers whose jobs required the use of two types of goggles would take a chance rather than stop long enough to change goggles. New eye protection goggles made by Willson Products are so constructed that they furnish protection, for example, to both chippers and welders.



New double lens goggles which give protection for two types of work

These goggles are on a composition frame fitted to the face. One set of lenses is made of clear, super-tough glass and is used during ordinary chipping or in work in which particles might fly toward the eye. Hinged above these, ready to snap into position with a flip of the hand, are two dark glass lenses to be used during welding operations for protection against dangerous light rays.

Food Fads Menace Health

FOOD faddists—"the vegetarians, the meat eaters, the drinkers of buttermilk, the gnawers of apples"—insult reason and menace health. Deploring the magnifying of half truths and other devices of "high powered salesmanship," Dr. Martin E. Rehfuss, professor of clinical medicine at Jefferson Medical College, Philadelphia, recently told the American Dietetic Association: "Diet faddists have reached a point where they are a positive menace to the health of the community and an insult to the reasoning of intelligent men and women." People have become food conscious to a superlative degree, Dr. Rehfuss declared.

Men and women in early stages of tuberculosis, cancer, and other diseases may be found today seeking relief in diet fads, he said, and meanwhile losing valuable time in getting treatment.

Dr. Rehfuss described to the dietitians biological experiments he has conducted which disprove the recent popular suggestion that proteins and carbohydrates should not be eaten at the same meal. Dr.

**Rehfuss tested the digestibility of these two kinds of food together when eaten by normally healthy people and in addition he tested 50 patients suffering from various diseases. Chopped beef was used in the tests to represent protein and mashed potatoes to represent carbohydrate. In the sick persons, some suffering from stomach disease, gall bladder trouble, nervous disorders, and other ailments, it took about three minutes longer for the stomach to digest the beef and potatoes together than the meat alone. This explodes the idea that these foods will not digest in the stomach when combined.—*Science Service*.

New Metal-to-Glass Seal

A NEW metal-to-glass seal has been developed by the Research Laboratory of the General Electric Company which, because of the certainty with which tight

Fernico sealed to a glass tube

and reliable joints can be made between glass and the alloy called Fernico, has opened up many possibilities in the development of various classes of vacuum tubes and other devices wherein leading-in wires or conducting parts must pass through gas-tight insulating seals or themselves form part of a gas-tight chamber.

Fernico can be machined, forged, punched, drawn, stamped, soldered, copper-brazed, and welded with a facility equal to that with which these operations can be performed on a high-grade nickel-iron.

The physical characteristic of Fernico which makes possible its successful fusion with glass is its expansion curve, which coincides almost exactly with that of certain glasses. For this reason, no stresses are set up in either the glass or the alloy when cooling from the fusion temperature. This lack of initial internal stresses in the completed glass-Fernico seal makes the seal permanently tight and unusually sturdy. Furthermore, no more care in cooling the combination is necessary than in dealing with glass alone.

The Impossible Trick

EPITOMIZING all the mystery of the glamourous East is the Indian Rope Trick, most famous of all of the miracles credited to the magicians of India. Nearly everyone has heard of this feat and has heard, too, that it is the one trick of the Indian fakirs that no American or European has been able to duplicate or even explain.

The trick was performed—so the ancient story goes—under a cloudless sky and in an open space, well removed from trees. The fakir, after appropriate mystic ceremony, tossed one end of a rope into the air. The rope remained perpendicular and stretched until the upper end was lost to view. A boy climbed the rope until he too was out of sight. Armed with a sword, the magician followed him up the rope. Soon the boy reappeared, but piecemeal—his legs, arms, head, and torso falling separately. The magician slid down the rope, placed the mutilated body and members into a basket. After more mystic rites, the boy emerged from the hamper, none the worse for wear.

The trick has been written about for years—for hundreds of years—and many explanations have been offered. Usually credited is the assumption, said to be erroneous, that Oriental magicians are so adept at hypnotism that they can hypnotise an entire audience to see what does not happen. Usually quoted to substantiate this is a venerable story—but only a story—of a smuggled camera that captured a picture of the magicians waiting for the spectators to come out of the trance.

Such has been the persistence of accounts of the "miracle" that scores of magicians have celebrated their arrival at affluence by making pilgrimages to India, hoping to see the trick or at least to talk to someone who had seen it. Kellar and Thurston were among those who made such fruitless journeys. They found, as others had found, that, surprisingly, the most famous of Indian tricks is not even known in India!

The most thorough investigation of the trick is credited to John Mulholland, one of the best known American magicians who shares with Howard Thurston the honor of being the only members of the craft mentioned in "Who's Who in America." Mr. Mulholland was a member of the faculty of Columbia University before he became a professional conjurer and carried into his Indian researches not only unusual technical knowledge of the psychology of deception, but the training of a scholar skilled in modern methods of research.

Mr. Mulholland, during his visit to India, was paid the signal honor of being adopted into the Bakhsh family of magicians, conjurers famous throughout the Orient. Mulholland's Oriental "grandfather," leader of the troupe, taught him all that the family knew about Oriental magic and then asked a favor of the newest member of the family: "Will you explain what tourists mean when they ask us to do the Indian rope trick? If American magicians know how to do it, we should like to add it to our *jadoo*."

Early prints purporting to depict the trick indicate that it was at one time thought to be of Chinese origin, so Mr. Mulholland sought records of the trick in China. While Chinese magicians did not adopt him, they did initiate him into their guild, the members of which assured him that they had never heard of the trick he was trying to trace. Mr. Mulholland ended his research believing that the trick possibly had its origin in the Chinese parallel of the universally known story of Jack and the Beanstalk.

According to students of the Black Art, Indian magic is much overrated and the real home of magic and conjuring is the West and not the East.—*Oil Power*.

QUEER ACOUSTICS

NOISE plays many tricks. In the great cathedrals of Milan, Cologne, and St. Peter's an organ note lasts so long that any rendition is a confused jumble. In St. Paul's in London and in the Hollywood Bowl it is possible for two people 90 feet apart to have a whispered conversation, owing to the acoustics.

The Precious Jewel

THE "precious jewel" in the head of the toad, about which Shakespeare wrote, is a gland which yields many important medicines, we are reminded by Dr. Edward Podolsky writing in the *American Scholar*. Among them are adrenalin, the greatest heart remedy at our disposal today; ergosterol, parent substance of rickets-preventing vitamin D; and other important ingredients.

The Chinese discovered the medicinal value of the toad ages ago. From its skin they prepared a drug which they called *senso* and which is in reality an impure product similar in its action to digitalis but 50 to 100 times as powerful. For centuries they have also used another remedy from the toad, a poison which they called *ch'ansu*. They used this for sinus trouble, for nose-

An old print from the John Mulholland Collection depicts the performance of the famous Indian Rope Trick — which probably never was performed —by ancient Chinese conjurers

bleed, and for pains of various sorts. This is none other than adrenalin which physicians use today to check bleeding and to give relief in asthma.

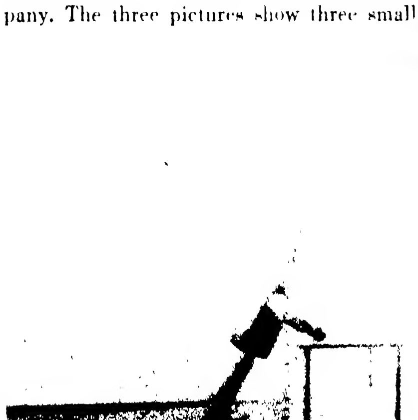
The toad carries these powerful remedies in his skin for reasons of self-protection, explains Dr. Podolsky. "When approached by an animal bent on devouring him the toad begins to secrete his adrenalin and digitalis, a taste of which usually discourages the larger animal from eating him. Should, however, the animal prove too greedy and throw all caution to the winds and devour the toad, the secretions of adrenalin and digitalis-like substances from the skin prove fatal to the devourer."

The Chinese obtained their toad medicines from the large glands located behind the toad's eyes by pressure and also by introducing garlic and pepper into the animal's mouth, whereupon it would cover its body with the secretion.

More than 20 years ago Dr. J. J. Abel of the Johns Hopkins Medical School was able to obtain adrenalin in its purest form, its crystals, for the first time, from the toad. He and Dr. David I. Macht of Baltimore obtained another powerful remedy, bufagen, from the parotid gland of a tropical toad known as *Bufo agua.* This medicine they found to have a marked action on the heart and also to increase the output of secretion from the kidney, which made it a valuable remedy in dropsy. Within recent years Drs. C. C. Chen and Hans Jensen, who started their investigations under Dr. Abel, have obtained six distinct medicines from the skin of the toad. *Science Service.*

Paint for Better Light—Better Sight

THREE of the accompanying illustrations tell a picture story, pure and simple, of tests conducted in the paint engineering laboratories of the Sherwin-Williams Company. The three pictures show three small



rooms, identical in all respects save one —the color of the paint on the walls. One is painted white; another is painted an aluminum gray; the third is black. The light source, outside the room, is identical in all cases.

In the white room the light is reflected in all directions and evenly dispersed to make an ideal working arrangement, utilizing all the light to its fullest value. In the aluminum grey room the reflection value is lower and the light has a spotty glaring quality. A foot-candle meter reading shows a marked lowering of the amount of light obtainable in the entire room, because more light is being absorbed instead of reflected. In the black room a spotlight effect is achieved, the dark wall surfaces reflecting practically no light at all.

Notice also that glare, a detriment to good visual working conditions, increases as the light reflection value of the wall surfaces decreases. Translated to factory walls, these pictures show what proper use of white paint means in vision, economy in lighting bills, rejections, and unit costs.

Cousin-Marriages

EXAMINE carefully the family history on both sides for at least three generations before marrying your cousin, is the advice of present-day geneticists, according to Dr. Charles B. Davenport of the Department of Genetics, Carnegie Institution of Washington.

Inbreeding is not in itself the cause of defective traits. Through inbreeding, however, existing traits, either good or bad, are strengthened.

Traces of muscular abnormality, dwarfism, epilepsy, feeble-mindedness, and insanity are the conditions to be carefully looked for in the three-generation history of both cousins. If persons in either direct

The three photographs on this page show the variations in room lighting, with the same light source, when walls are in different colors

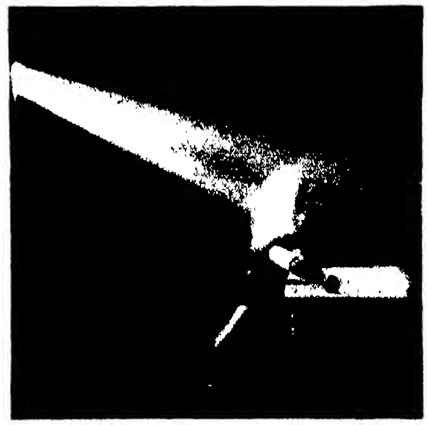
or collateral lines within the three generations are found having any of these defects, the marriage between the cousins is hazardous for the offspring. *Science Service.*

Radium in Canada

REPORTS of a rich radium deposit in the Great Bear Lake region of northern Canada, in the same place where sensational silver discoveries have been made, have attracted the interest of the mining world. It is said that 30 tons of pitchblende concentrates, averaging 60 percent uranium oxide, have been accumulated at the refinery. This concentrate represents one gram of radium for every six tons, it is reported.

A new structure is being erected at the company's refinery in Port Hope, Ontario, to treat the concentrate, which will be brought to railhead by airplane. Silver concentrates, averaging between 3000 and 4000 ounces to the ton, and possibly crude bullion will be made at the mine where 60 men are working.

Chemical interest centers in the work of the Federal Department of Mines. A report on their investigations just published describes in detail the process evolved for the successful treatment of the Great Bear Lake pitchblende for the extraction of radium. Two methods have been developed to obtain the best results, as two types of ore were found: High-silica-gangue type pitchblende; and carbonate-barite-gangue type pitchblende containing silver. The mill flow sheet and details of the extraction process, leading to a high recovery in both instances, are described fully. A report of



the radium-measuring laboratory and an account of the precautions taken to protect workers engaged on radium ores are also included. *A. E. B.*

OCEAN DEPTH READINGS EVERY TEN INCHES

THE Fathometer, used for years to obtain quick soundings of the depth of the ocean bottom by sending a sound from the bottom of a ship and noting the time lapse before the echo is received from the ocean bottom, has now been improved to such an extent that 20 soundings in shallow water may be made each second. This means that a survey boat cruising at 10 miles an hour can obtain soundings of every 10 inches of bottom in shoal water ranging from a depth of six to 120 feet.

Astronomers Uncertain of Next Bright Comet

THOUGH dozens of comets have been observed through observatory telescopes in the last few years, and many more as bright are expected in the near future, astronomers do not know when one brilliant enough to be conspicuous to the naked eye will appear. It is reasonable to expect "one or more great comets some time within the next 50 years but whether one will come next week or next year or not in the next ten years, no one can say." So reports Dr. Robert G. Aitken, director of the University of California's Lick Observatory.

During the 19th Century, he states, "five comets of the first rank appeared and at least six others that were fairly brilliant." One of these was Halley's, which returned in 1835. Another was the Great Comet of

1882. Halley's made its next visit in 1910, and while astronomers have not yet calculated the exact position and date of its next return, which will depend upon the amount that it is pulled by the gravitational attraction of the planets, it is confidently expected about 1985.

All the other bright comets that have appeared in the past, says Dr. Aitken, have their periods "numbered in hundreds of years, and not one is known well enough to permit the prediction of even an approximate date for its return. When one comes, it will come unheralded."

Astronomers will be able to study it with facilities not available previously, he declared. "The modern astrophysicists are far better equipped for observations in these lines than were the observers of the Great Comet of 1882 or even those of Halley's Comet in 1910. When the next great comet appears they will apply every resource at their command to study every phenomenon it presents, and they are eager to enjoy the opportunity," he said.—*Science Service.*

DESTRUCTIVE BEAVER

SENTIMENTALISTS who connect the beaver with our pioneer days have agitated for years for the return of the beaver; that is, they believe we should give beavers an opportunity to multiply. But the beaver can be very destructive. The water supply failed recently at Yellowstone Park's hydroelectric plant and the plant had to shut down. It was found that beavers had completed a new beaver dam directly on the protecting grating in the intake pipe line.

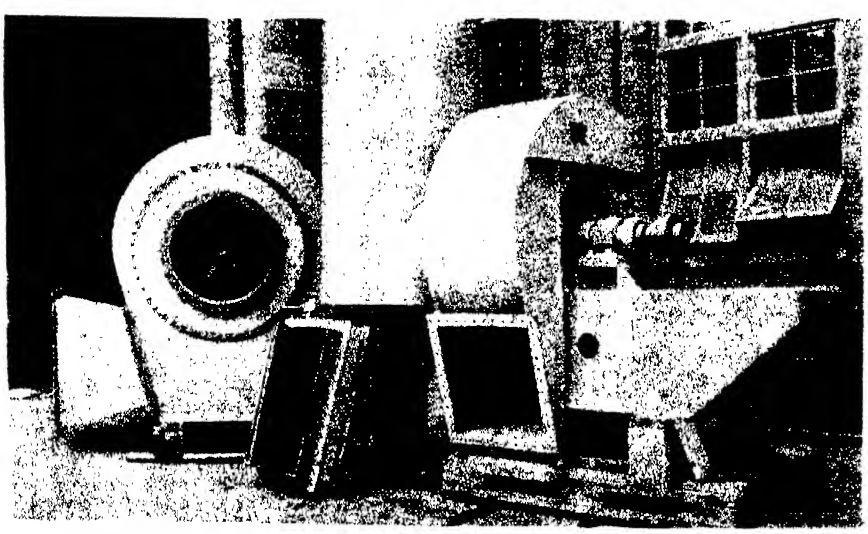
Acid-Proof Rubber Covering on Fan Units

THE bathing beauty with the skin-tight rubber bathing suit has nothing on the exhaust fan units in the illustration; they have their suits of rubber, too. And the fit is perfect, more tenacious.

The practicability of utilizing acid-proof rubber covering to eliminate destructive corrosion in many types of machinery is exemplified in large exhaust fan units recently rubber covered by The Manhattan Rubber Manufacturing Division.

This covering is a specially-developed acid-proof rubber compound applied by a perfected process to the metal surfaces of the fan unit.

The process of uniting rubber to metal holds the rubber covering in place so tenaciously that after vulcanization, the cover cannot be removed without tearing and destroying it.



Two large fan units covered with rubber to eliminate destructive corrosion

Mile-Range Flashlight

IMPROVEMENTS in flashlight batteries and cases developed by the Bond Electric Corporation, have made it possible to produce a mile-range searchlight. This "Big Bertha of flashlights" is made in two long,

The "Big Bertha" of flashlights

tubular fiber barrel sections, each a complete self-contained unit. It can be used as either a five cell searchlight, or a long range 10-cell searchlight by screwing the two 5-cell sections together. A large non-rolling focusing searchlight head holds a brilliant reflector, and a specially designed, 11.8 volt, tubular bulb is included to be used with 10 cells. A spare bulb carrier contains a 6.2 volt bulb to be used with the 5-cell searchlight and an extra 11.8 volt bulb.

The new mile-range searchlight is controlled by a modern three-way safety switch.

A Pelican Flower Blooms

ONE of the oddest members of the plant world was recently in bloom at The New York Botanical Garden in New York. Its curled-up tube, expanding at the end into a flat, shield-shaped, purple-veined blossom gives it the common names of pelican, swan, goose, or duck flower. It is a close relative of the common vine known as dutchman's pipe. But this particular species, which is the giant of the genus, going by the scientific name of *Aristolochia gigas*, looks in side view like the head and neck of a pelican. It is as queer among flowers as the pelican is among birds.

The flower has a long twisted tail hanging down from the expanded purple-veined

A rare pelican flower in bloom

calyx, which is six inches in diameter, and has no proper petals. The tubular calyx is bent into a puzzling maze for unwary flies attracted by the carrion scent of the bloom. The plant is a native of the West Indies and northern South America, and in its native jungles is a woody climber. It is seen only rarely in collections of unusual plants.

Childless Couple's Chance for Child Doubled

WOMEN who seek medical aid to overcome involuntary childlessness now have double the chance of realizing their natural dream of bearing children of their own, it appears from results obtained at the Evans Memorial Institute, Massachusetts Memorial Hospitals, in Boston.

The secret of success in bringing the boon of children to previously childless couples lies in recognition of the fact that childlessness may be due to multiple causes operating in both partners to the childless marriage, according to Dr. Allan Winter Rowe, director of the Institute.

Fifty out of 100 couples were helped to have children of their own by Dr. Rowe and his colleagues. Reports in medical literature show that the best results previously obtained have enabled only 25 out of every 100 couples to achieve parenthood. Working with Dr. Rowe in his efforts to overcome involuntary infertility were Dr. Samuel R. Meaker, Dr. Samuel N. Vose, and Dr. Charles H. Lawrence.

The first step in the proceedings to help the childless couples was a thorough study of the histories and physical condition of both husband and wife. These studies and examinations showed that both the men and the women were suffering from a number of constitutional and glandular abnormalities. Disorders in varying degree in both men and women were found in thyroid, pituitary, and sex gland functions. Anemia, over- and under-weight, depressed energy metabolism, low blood pressure, signs of liver injury indicating toxic conditions, and veneral, tubercular, and other infections were found in both men and women.

Only nine of the men and three of the women were adjudged normal. With some exceptions, no one of the abnormalities found would by itself have prevented the couple from having children, Dr. Rowe explained. But the combination of several of the abnormalities in both partners to the marriage were in his opinion sufficient to cause the childlessness. In order to raise the chance of the couple for having children to its very highest, all the abnormal conditions had to be corrected. The constitutional factors such as anemia, focal infections, depressed energy metabolism, malnutrition, and disordered liver function played a major rôle in contributing to the childlessness, he believes.—*Science Service.*

Amateur Radio in Sports Reporting

AMATEUR radio is being found at an increasing number of sporting events these days. For several years, radio amateurs have provided communications at the National Air Races and the National Soaring Meets. According to reports reaching the headquarters of the American Radio Relay League, during the last summer these activities were expanded to include regattas and motorcycle runs. Amateur radio is highly useful in any event where there is a long course to be run; observers are stationed at intermediate pylons, checking stations, official barges, and so on. And the "hams" get a big thrill out of doing the work.

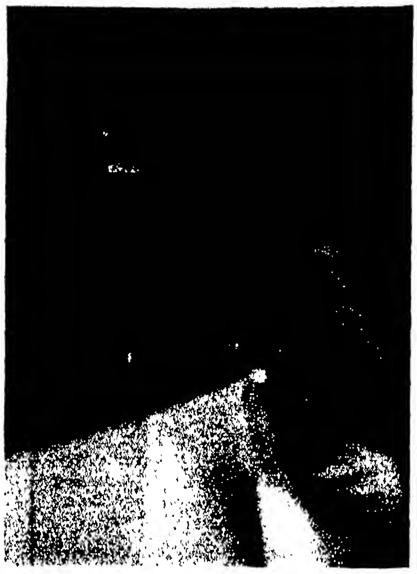
Moths by the Thousands

A LABORATORY that uses moths and moth larvae instead of guinea pigs, rats, or white mice is boasted by the Collins & Aikman Corporation, large upholstery manufacturers. The "moth-room," containing tens of thousands of moths, eggs, and larvae is located in the company's Philadelphia plant.

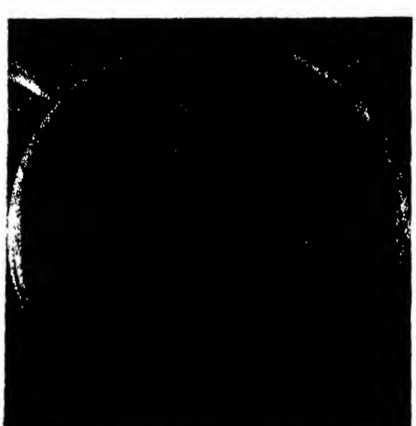
According to Mr. W. F. Bird, in charge of research, it is no easy matter to find moths for test purposes—a statement that the average housewife might dispute. However, Dr. Bird declares that the company employs a fair-sized corps of moth-catchers who are paid five cents for each specimen of the genus *Tineola bisellielia Hummel*, or the *Tinea Pellionella L.* delivered alive to the laboratory.

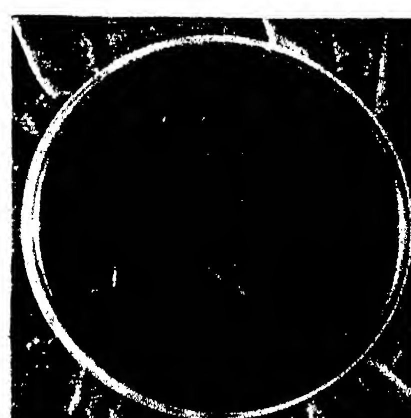
Once in the laboratory, the moths are quartered in the greatest luxury. They are kept in a chamber that is unique in scientific research, but which would give the orderly housewife aggravated nightmares. It is literally alive with moths, which are fed the choicest of animal yarns. Since moths like warmth and darkness, the room is electrically heated and lights are switched on only when a laboratory worker enters the room. Special insulation serves two purposes—it helps maintain the temperature and keeps the larvae from getting out.

Although the moths are pampered to the greatest extent, they are in effect betrayers of their kind. Their purpose is to prove the efficiency of mothproofing processes developed by the corporation. Largely as a result of the yeoman service done by the moths, the company was recently able to guarantee all their mohair furniture upholstery against moth depredations for five years—and back up the guarantee with an insurance policy underwritten by a large insurance company.



If for any one of several possible reasons, you have trouble in finding the keyhole at night, the Knocker-Lite will solve your problem. Just lift the knocker and a tiny lamp lights up the keyhole. Two small batteries provide the current





***Left:* What moths can do to untreated mohair fabric. *Right:* "Hand-raised" moths starved to death on moth-proofed mohair fabric**

Warns Against Two New Drugs

WIDESPREAD use of two dangerous drugs—one which destroys the liver and the other which kills the white corpuscles of the blood—has brought a warning from the Federal Food and Drug Administration. These drugs are cinchophen and amidopyrine. Cinchophen, a chemical anodyne and sedative, is sometimes used by sufferers from neuralgia, rheumatic pains, neuritis, and similar conditions. Amidopyrine is frequently found in headache remedies and other pain killers.

"Current medical literature contains many reports which clearly indicate that these drugs are dangerous to health and life," says W. G. Campbell, Chief of the Food and Drug Administration. "The gradual development of serious poisoning from the use of these drugs is often so insidious that the danger is not recognized by the user. Cinchophen causes a degeneration of the liver cells. Amidopyrine may cause a reduction in the number of white blood cells, a condition called agranulocytosis."

In issuing the warning, Mr. Campbell made it plain that he was not implying that all headache and rheumatism remedies contained these dangerous drugs. But the fact that some of them do is sufficient reason for the public to be careful. Several manufacturers declare on their labels the presence of these drugs in their medicines, but others do not. There is no provision in the Food and Drugs Act to compel manufacturers to declare either of these drugs.

The Federal Food and Drugs Act requires manufacturers to declare upon the labels of their products the presence of several narcotic drugs. When the law was passed, cinchophen was unknown and the dangerous effects of amidopyrine had not been recognized. For these reasons these drugs were not included in the list.

Under present conditions buyers should observe two precautions, says Campbell. First, read the label and look for statements of the presence of these drugs. If they are not declared and there is any doubt ask the druggist or write to the Food and Drug Administration in Washington and ask for the facts.

CITRUS FRUITS IN ALUMINUM

AN agricultural experiment station in Florida, having tested various wrappings for citrus fruits, finds that aluminum foil and Cellophane are "clearly and consistently superior to the common tissue and oil papers" now in use. Their advantage lies in their ability to decrease the loss of moisture from the fruit. They have kept fruit in firm, sound condition for long periods.

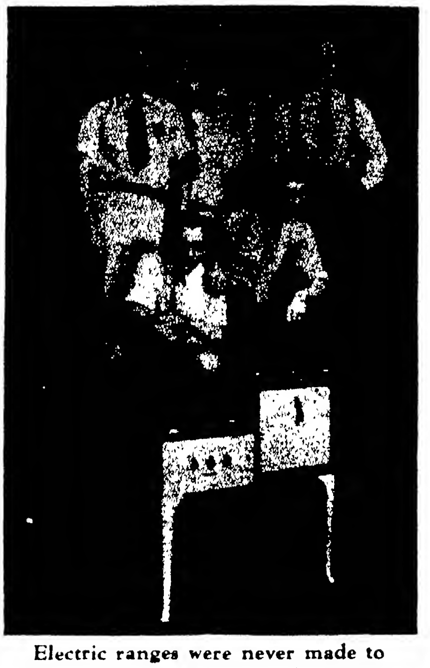
Rare Metals Respond to Ultra-Violet

RARE metals, having healing and curing properties, will add many years to human and animal life, as well as improve and increase the nutrition in food products and eventually control production of crops. These rare metals, uranium and thorium, scientists' contribution to mankind, scarcely known outside of the research laboratory,

now are used in photo-electric cells, glow tubes, and X-ray targets, Dr. J. W. Marden, Assistant Director of Research of the Westinghouse Lamp Company, told members of the Electro-chemical Society at their recent 66th Annual Meeting.

Seventeen years ago, when Dr. Marden started his researches on rare metals, pure uranium and thorium were not available at any price but they are now gradually becoming more common.

"Thorium and uranium," said Dr. Marden, "find a use in special photo-electric cells where no other metals can be substituted. Each metal becomes active to light at its own specific wavelength; that is, uranium will detect one portion of ultra-violet light while thorium will detect another portion. Several hundred grams of thorium are used every month in glow tubes employed for measuring devices which determine accurately the amount of radiation given in a portion of the spectrum. Not only do these meters estimate the intensity of radiation at a given time but they also show the total amount of radiation falling for any period of time. The uranium photo-electric cell is used for measuring the ultra-violet radiation which causes tan and for measuring radiations such as are used for producing vitamin D in food products."—*A. E. B.*



Electric ranges were never made to be used in this manner, but since this new Westinghouse range has a welded body like that of a modern automobile, it can support great weights; that is, it is rugged. No bolt or screw heads are in evidence. Mass production methods are used

Age Does Not Determine Vitality of Farm Seeds

HOW old can seed of grain and forage crops be and still grow? Over and over, farmers ask this question of seed men in the United States Department of Agriculture. "The vitality of any seed cannot be stated in terms of age," replies Edgar Brown, in charge of the Division of Seed Investigations. "Any attempt at generalization as to what percentage of any seed crop will germinate at any age, in any climate, is futile. No rules can be laid down. In general, older seeds do not germinate so well as fresh seeds." Seed deteriorates more rapidly where the climate is warm and moist than where it is cool and dry.

Many examples prove that age does not determine the percentage of seeds which will grow. At the Ohio Agricultural Experiment Station, seeds of different field crops were collected for a series of years, put in corked glass bottles and stored under identical conditions. In February and March of 1920, all were tested. Alsike clover seed from the 1915 crop germinated only 62 percent while seed from the 1910 crop had 90 percent germination. But germination from the 1911 crop was only 13 percent. Field corn from the 1915 crop germinated 3 percent; that from the 1912 crop, 57 percent. Field peas from the 1912 crop had a 95 percent germination; from the 1915 crop only 26 percent grew. Only one percent of the 1917 timothy crop grew, but the germination of the 1916 crop was 83 percent. Seed of good quality originally, if properly stored, will keep its germinating powers much longer than poor quality seed.

OIL UNDER THE DEAD SEA

GEOLOGISTS have at length come to the conclusion that oil pools may underlie the bitumen areas in the Dead Sea region, and representatives of various petroleum companies are now engaged in systematic exploration of the district.

Canned Reducing Diet

SO widely was the banana-and-skimmed-milk reducing diet publicized that a commercial food has been developed to supply it in combined form, reports *Food Industries*. The new product consists of dehydrated bananas and dried skimmed milk, with approximately 400 units of vitamin A and 200 units of vitamin D added per ounce to give higher health value.

Ripened in an air-conditioned room, the bananas are dehydrated, 12 pounds of fruit making about 1 pound of powder. Two parts of this powder are then mixed with three of the dried skimmed milk, after which the vitamin, concentrated from cod-liver oil, is added to produce the combination known as Banola.—*A. E. B.*

A clear, water-white plastic is used in this transparent draft gage. The inclined tube and oil chambers are accurately reamed in the solid Resinoid casting. Since there is no metal casing, all parts are fully visible and the leveling bubble is free from shadow and is very easy to read

Reflectors Catch Wild Bird Songs

THOSE queer looking groups of what appear to be huge loudspeaker horns which were used during war time for detecting the approach of airplanes have been put into use in an interesting peacetime study. At least the sound reflectors used by Paul Kellogg of the Laboratory of Ornithology at Cornell University are similar in principle. With such portable units he has captured for the purpose of further study the songs of wild birds in their native habitats. In cases where birds were frightened, he has carried a microphone on a long cable some distance from the "sound truck."

Baby's Cuff

TO prevent babies from sucking their thumbs or other fingers, a practice said by pediatricians to deform the teeth and the roof of the mouth as well as the fingers, a device known as the Bo-Peep Cuff has been developed. It is made of the transparent, non-inflammable du Pont material named "Plastacele," with an elastic wristlet to hold it on. As illustrated, the cuffs make it impossible for the child to get his thumb or fingers into his mouth, although he can see his hands and hold a rattle or other object. They also prevent the baby from scratching an infection or rash.

Cuffs keep baby from thumb sucking

'Ware of Highfalutin' Words

"IT seems," says W. W. Coblentz, Ph.D., of the National Bureau of Standards, in making a report to the American Medical Association on sources of ultra-violet and infra-red radiation, "as though there has never been such a widespread attempt as today to foist on an unsuspecting and trusting public all sorts of alleged physical cure-alls to relieve people's ills and to keep them in health. Prominent among these panaceas is the exploitation of ultra-violet and infra-red rays. The mere mention of 'infra-red rays' creates in the mind of many persons a feeling that this is something new and mysterious that they have missed, when, as a matter of fact, it is difficult to think of a warm object that does not emit infra-red rays.

"When an object is heated to a higher temperature than its surroundings, an ex-

cess of infra-red rays passes from it to the surrounding objects. Examples of sources of infra-red rays are arc lamps, incandescent lamps, coal fires, steam pipes, and hot stoves. Because of the low temperature, the infra-red rays emitted by hot water bags and electrical heating pads are of low intensity, and hence they are insignificant in comparison with the amount of heat that is obtained by conduction, by having the hot pad or hot water bottle in contact with the body. Of course it sounds more impressive to speak of infra-red rays than to speak of the application of heat by conduction, by direct contact of the pad with the body.

"There is nothing new or mysterious about the ultra-violet and the infra-red rays. A person is always exposed to the infra-red rays when standing near a steam radiator, an open grate fire, or even an electric toaster. The spectral quality and total intensity of the infra-red rays emitted by the radiant heaters for warming rooms are essentially the same as emitted by the infra-red lamps sold for therapeutic purposes, except that the latter have smaller reflectors and have more elaborate adjustable mountings, which cost more money."

Aircraft Flare

A FLARE for use in connection with aircraft and which will give a light intensity of approximately 350,000 candlepower for a period of three minutes is being

350,000 candlepower for three minutes

used by the larger airlines in the United States as well as in China and Sweden.

The flare, as shown in the accompanying photograph, consists of a section of aluminum tubing of approximately 28 by 5 inches which contains several pounds of inflammable material including three pounds of aluminum powder.

A Guide for Inventors

A LONG felt want is satisfied in the establishment of an intelligent and dependable organization for guiding American inventors. The genius of the American inventor is, of course, proverbial, but he often lacks the practical knowledge to enable him to develop his inspiration properly and assure his share of profits. The Inventors Foundation, recently opened, is the first effort of its kind in the long history of invention to awaken a fuller realization of the pleasures and gain to be derived from inventive achievement.

The opening of the Foundation in New York follows painstaking research at Stevens Institution of Technology and New York University, in association with the International Correspondence Schools. It has been found that inventors are often surprisingly ignorant of the patent laws, and of the most efficient methods for protecting their own interests to secure adequate returns. The Inventors Foundation, which is conceived on broad philanthropic lines, offers courses in these educational institutions and by mail in all details of invention and patent methods. The inventor in New York or any part of the country can thus receive expert training and practical guidance.

The inventor is first instructed concerning the best protective methods for original ideas, and the practical application of this information throughout every stage of the development of an invention. The pitfalls are carefully charted so that the inventor, however inexperienced, may avoid them. The inventor is likely to be a dreamer and unfamiliar with business methods and the Foundation gives him practical instruction and guidance when he is most in need of it.

The courses include an intelligent study of the inventors' market for the particular product in hand. The most idealistic and unbusinesslike inventor thus becomes expert in safeguarding his own interests. In all these details he has the advantage of the experience of men skilful in every phase of invention. The Foundation, in short, is prepared to answer all the inventor's questions and satisfactorily solve his many perplexing problems.

The Inventors Foundation has been founded by Henry J. Gaisman, himself a veteran inventor, and the creator of some of the best known inventions in the world. Having learned by much bitter experience the dangers which beset the young inventor, Mr. Gaisman has established regular courses of instruction in patent procedure at New York University and at Stevens Institute and by mail.

"Laytex"

LAYTEX, a new insulation for wires which promises to contribute largely to the electrical industry and to play an important part in the progress of more than a score of allied industries, was announced recently by the United States Rubber Company.

Included among the industries which seem destined to make use of Laytex are the automotive, aviation, building, chemical, contracting, engineering, machine, marine, mining, petroleum, paper, power, plumbing, heating, radio, refrigeration, railroad, textile, welding, and others.

Laytex is said to possess properties so superior to those of ordinary flexible insulation that in time, the manufacturer believes, all existing codes and specifications on wire insulation will have to be re-written. For example, compared with ordinary insulation, Laytex is claimed to be more flexible, and to permit thinner but superior walls which make possible finished conductors lighter in weight and smaller in bulk.

Laytex is derived directly from latex, the milk of the rubber tree. Through patented processes are removed all proteins, sugars, and water solubles—the materials which are susceptible to moisture and which make a "sieve" of ordinary insulation.

A conductor is then run through a series of baths of liquid and during each bath the conductor takes on a film of insulation which is almost immediately converted from liquid to solid. The liquid is solidified on any given section of the conductor before

(*Please turn to page* 48)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

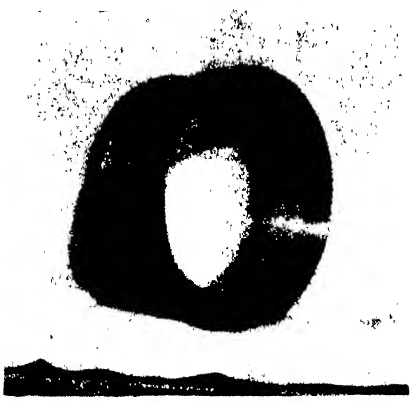
THE article on the design of telescope sights for rifles, by Alan R. Kirkham of Tacoma, which was begun in last month's number, is concluded this month as follows:

THE actual grinding and polishing of small lenses is well described by Porter in the book "Amateur Telescope Making," beginning at page 66. The eyepieces may be mounted without any tests. The objective and each component of the erector should be tested, with crowns facing the light, by the method given at bottom of page 444. The curving of the Ronchi bands, indicating hills or hollows, should be interpreted exactly opposite to the descriptions on page 264, which apply to mirrors. The objective may be figured by making a little pitch tool on a board, and polishing by hand in such a manner as to hit the high spots. The erector lenses are seldom much over a half inch in diameter, and will nearly always be found perfect if made with reasonable care. Should a distinct error be found in one, it will probably be best to regrind and polish it. Before testing, the lenses should be "dummy-cemented" with glycerine, to take the place of the balsam which will finally be used. Figuring done on cemented surfaces is practically without effect. Try the crown both ways (if it is equi-convex) and leave it the way it will require the least figuring. When the errors are all removed, and the Ronchi bands are practically straight, the lenses are ready to be balsamed together.

The balsam sold by most opticians, for cementing microscope cover glasses to slides, is satisfactory. Clean the lenses absolutely spotless, put a drop of balsam on the flint, and lower the crown squarely over it. Finally press them together, being careful not to let them slip around on one another, until all surplus balsam is squeezed out of the edges, which may be wiped clean frequently with a rag *barely moistened* with xylol. The lenses are then baked for three or four hours at a temperature just above what the hand can bear.

LITTLE will be said about the mounting, since it would be almost futile to attempt the job without some knowledge and skill in mechanics. The mounting presents nothing unusual in the way of lathe work, but the lenses should be rather firmly mounted, with quite a wide rim for a seat, in order to withstand the recoil. The reticule is situated at the focus of the eyepiece, and should be adjustable to and from it, for paxallax. Focusing may be accomplished by moving the eyepiece and reticule together, or by moving the erector lenses as a unit, the latter being the prevailing practice. The reticule could be moved by screws or levers for windage and elevation.

Two questions are likely to arise. First, how much distance should be allowed between the erector lenses, if they are separated? Separation of the lenses a certain amount is supposed to improve the color correction under some circumstances, though it has other effects, both good and bad. Practically, it seems to make little or no difference, and the builder may suit his whims, up to half or three quarters of an inch. Secondly, the designer is almost sure to find that the exit pupil diameter and the magnification he picks in the beginning, will require an unreasonably large objective. This is a far more important consideration than the first. Since the second part of the formula given last month for the objective diameter depends only on the width of field, this is another reason for not trying to obtain extremely wide fields. One should make careful drawings, after the plan of Figure 2 (see last month's installment), and study them in order to deduce what changes can be made.



A cell, housing a 5½-inch objective lens, made by the author

Of course the formula mentioned represents the ideal, with which all parts of the field will be equally bright. Obviously, if all of the rays, when traced backward as in Figure 2 from the stop at F_2, do not succeed in getting through the objective, the only effect will be a slight diminution of brilliance at the edge. With large exit pupils, one could afford to lose perhaps half of the light at the extreme edge of the field, and the effect would not be detectable to a casual user.

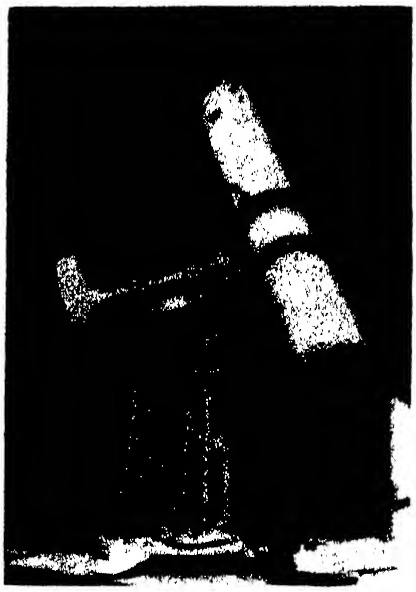
It is necessary to cut and try, in designing these systems, and one is almost always forced to make compromises either in the brilliance of the edge of the field or its width, if he is to obtain either large exit pupils or wide fields. It is often difficult for the layman to realize that these systems are always designed either by whim, or by an ordered effort along experimental lines, in order to obtain desired ends, and that there are no magical formulas which will answer the question, "What kind of sight do I want?"

THIS concludes Mr. Kirkham's article, but in a subsequent communication to your scribe he recommended that no unusual designs be attempted as the first job. There will be enough grief in the usual types, no doubt, to satisfy most workers.

Commenting at our request for data on spotting telescopes—that is, instruments used by the marksman to inspect his target after firing on the range—Mr. Kirkham writes: "A spotting 'scope is merely a small refractor of rather short focus, equipped with Galilean eyepiece, an erecting eyepiece, or a three-prism erector and standard eyepieces. The Galilean is by far the simplest and cheapest, but not very fancy (small field of view—*Ed.*). Erecting eyepieces have many bad traits and are not used much now, being almost wholly supplanted by three-prism erectors employed in connection with standard eyepieces and this permits the use of ordinary kinds of positive eyepieces, which are highly developed. The worker should make the objective according to the instructions by Ellison in 'Amateur Telescope Making,' and the eyepieces according to Hasting's dope in the same book, and for the erector system, buy cheap prisms, with hypothenuse side twice as long as the diameter of the field lens in the largest eyepiece he wishes to use."

A science teacher, Miss Catherine Cassidy, and three science students, the Misses May Hearn, Ida May Nance and Florence Sinclair—all of the East Carolina Teachers College at Greenville, North Carolina, and a telescope they jointly made. The college electrician helped with the mounting job

THERE are no short cuts to the consummation of the telescope sight job, and the worker who has omitted to develop background—or what might be called "optical gumption"—by doing various jobs of a simpler nature, such as making a reflecting telescope with mirror, will probably sweat more profusely over a telescope sight than the other fellow who has built up some experience over and above



An old reflector made as a stock product by the late John A. Brashear and picked up years later by L. A. Baldwin of Troy Hills, N. J. The professional design may be of interest. Note rugged declination axis, yokes, and connecting parts. No shimmying in this mount

that which may be gained from reading books. But the satisfaction of shooting with your own sight would be worth it.

THE following note is from E. Lloyd McCarthy, the same whose focograms appear on page 389 of A. T. M. Mr. McCarthy is now an assistant at the Yerkes Observatory, in Williams Bay, Wisconsin, and he writes: "In casting about for simple means of testing a lens I have been computing, free from coma and spherical aberration, it occurred to me that the autocollimation test could be performed with a vertical set-up and a pan of mercury for the optical flat. Perhaps the idea has been suggested before. I examined the figure of a cheap field glass objective by this means, and found that the tool marks were readily visible. Setting the pan of mercury on a concrete basement floor, I had no trouble with vibration. If you think the idea is new and any good, it might be welcomed by those amateurs who, like me, are forced to economize in their optical work." Mr. McCarthy's set-up is the same as Figure 10, page 121, of A. T. M., with the pan of mercury substituted for the plane mirror *P*, and the whole thing turned to a vertical position so that the eye looks downward.

SO many are the separate groups of amateur astronomers and telescope makers around San Francisco Bay that they have organized their various galaxies into one super-galaxy. C. R. Tinsley of Berkeley tells us that the Amateur Telescope Makers of San Francisco, under the leadership of Dr. Frances W. Epley of the Flood Building, that city, and the Amateur Telescope Makers of Berkeley under the chairmanship of Dr. W. P. Bush, American Trust Building, Berkeley, California, with clubs in Oakland and other Bay cities, have federated into the Amateur Telescope Makers of the Golden Gate, and will meet quarterly. It will be hard to beat that name.

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 45)

the section is in physical contact with any mechanical support, and because of this, mechanical defects are avoided.

Elongation tests show that Laytex has a stretch of 750 percent, which establishes it as the most flexible insulation known. This extra stretch naturally provides an important margin of safety.

The tensile strength of this new insulation is 5000 pounds per square inch, which approaches the tensile strength of non-flexible types of insulation. It is possible that Laytex, on account of its great strength and resistance to compression may be adapted to service conditions in which non-flexible metallic coverings are now necessary.

Owing to the purity and uniformity of Laytex, it has the highest dielectric constant of any known flexible insulation. Its insulation resistance constant is more than twice as high as that of the best grade rubber compound required by the American Society of Testing Materials specifications.

Partnership or Debating Society?

THE 50-50 marriage has a much greater chance of success than does the marriage in which either the husband or the wife takes the leading rôle. But this sort of marriage should be co-operative, not competitive. This is the conclusion of Dr. Paul Popenoe from his experience with thousands of married couples at the Institute of Family Relations.

"Among 13,000 clients of the Institute of Family Relations, virtually every one who complained of unhappy marriage also revealed failure to co-operate successfully in homemaking, with incessant conflict growing out of that failure," Dr. Popenoe said in a report to the *Journal of Home Economics.*

The general idea of young couples who wish to attain a co-operative marriage is that co-operation consists of talking over each problem as it arises until some sort of decision is arrived at. This is the wrong way of going about it, Dr. Popenoe indicated. The only way to attain true co-operation in marriage, he believes, is through division of labor. For both husband and wife to work together on every family matter virtually turns the family into a debating society.

"It means unlimited argument over all sorts of inconsequential points. It is the feeling of most married men, I believe, that their wives attach too much importance to this process. In his study of marriages, G. V. Hamilton asked his subjects what they found most annoying in their respective mates. Most of the husbands said their wives talked too much. Most of the wives said their husbands did not talk enough."

If either one of the partners in a marriage is to be dominant, the ascendancy of the husband is most likely to result in happiness. The figures show 61 percent of marriages happy when the man is boss, 47 percent happy when the wife is boss, but 87 percent happy in the 50-50 marriage.

"When the man dominates the marriage it is partly because he has a dominant personality, partly because economic and social conditions give him an advantage," Dr. Popenoe said. "He is also greatly aided by the fundamental disposition in most women to admire a strong and dominant man and to be willing, in fact happy, to accept his protection and leadership."—*Science Service.*

AMBERGRIS OUTDONE

HERETOFORE no fixatives known to the perfume industry have equaled musk, tonkin, civet, ambergris, and castoreum, products obtained from animal and plant life. Recently, following a discovery by du Pont chemists, a new product called Astrotone has been developed, and this aromatic now looms up as a potential leader. Because it is a water-white liquid and does not discolor, it may be used in many preparations other than perfume. Astrotone sells for approximately 200 dollars per pound.

Research Makes For Safer Transport

SAFER motor cars, airplanes, and railroads may be expected as the result of new research on metals. While industry has been making such things as steel for years, the metal had varying sizes of crystals. This made for unevenness of properties of the manufactured product and made it necessary to have large factors of safety in elevator cables, steel buildings, and similar equipment.

Such factors of safety were really factors of engineering ignorance; they were the margin of safety by which engineers allowed for their lack of knowledge about a metal's strength. It has now been found that a decrease in the size of metal grains makes for toughness in the metal.

New work in the last two years has shown, for the first time, how the grain size can be controlled. The public may expect safer motor cars, airplanes, and railroads as a result.—*Science Service.*

Pictures by Radio

A NEW radio facsimile system which reproduces entire messages, maps, and pictures directly on ordinary paper at the rate of a full letter-sized sheet every eight minutes, was described recently by Charles J. Young, research engineer of the RCA Victor Company.

While Mr. Young emphasized that it is premature to attempt to evaluate all of the practical uses to which the new development might be put, he suggested that such a simplified system could be used to flash messages in their entirety, from city to city, exactly as written by the sender, to supplant the present method of sending such messages, letter by letter, in the comparatively laborious Morse code. He pointed out that the new facsimile system should prove useful in police and crime detection work. Fingerprints, identifying photo-

graphs, and other useful information could be exchanged by police departments to aid in the apprehension of criminals.

The recorder system developed by Mr. Young in the RCA-Victor laboratories dispenses with the cumbersome processing, or photo-developing required by other facsimile systems, by utilizing ordinary carbon paper to print directly on ordinary white paper. Continuously feeding rolls of both the carbon and the paper are led past a metal cylinder, on which a single spiral of wire projects slightly above the surface. The fluctuations in the intensity of the incoming signals press the paper and carbon together against this spiral to make marks corresponding to the lights and shades of the original at the transmitter. Since the receiver and the transmitter are synchronized, an exact reproduction results. The facsimile recorder described by Mr. Young traverses a standard width letter size page, measuring 8½ by 11 inches, at the rate of 1.2 inches per minute. Thus, a full-sized page filled with single spaced typing is completed in eight minutes, or at the rate of 100 words per minute.

DARNED HIS LEG WITH HORSEHAIR

THE Australian bushman or farm worker seldom lacks initiative. Badly cut in the leg by a wire rope, a farm worker near Dorrigo, New South Wales, could get no immediate medical attention. So a fellow worker pulled four hairs from a horse's tail, and using a darning needle stitched up the wound. A cork proved a failure as a thimble, but a penny was quite successful.

The injured leg has now healed completely, without after effects.

Rare Element Found in Siberia

THE rare chemical element, gallium, has been extracted from minerals found in the Altai Mountains of Siberia, Prof. V. E. Zviagintzev, of the Russian Academy of Sciences, has revealed.

Gallium is a metal which melts at 30 degrees, Centigrade, or 86 degrees, Fahrenheit. Its boiling point is greater than 1600 degrees, Centigrade, nearly 3000 degrees, Fahrenheit; mercury boils at 356.9 degrees, Centigrade, or 675 degrees, Fahrenheit. It is therefore more useful than mercury in the manufacture of thermometers for use at high temperatures. Gallium is also used in medicine.

The existence of gallium was predicted in 1869 by the Russian Mendeleeff, who developed the periodic table of chemical elements. It was discovered two years later by the French chemist, Lecoq de Boisbaudran. So far only relatively small quantities of gallium have been available, extracted mainly in Germany and in the United States.

In 1931, Prof. Grinberg of the Institute of Platinum of Leningrad suggested that the zinc ores of the Ridder deposits in the Altai Mountains might contain the rare element, as do the Canadian deposits. The Institute of Rare Metals of Moscow took up the suggestion. Spectroscopic analysis of the Ridder zinc ores showed the presence of gallium, and treatment of zinc concentrates yielded a small amount of gallium oxide. Prof. Grinberg is now leaving for the Altai Mountains to study on the spot the best methods of extracting this important rare metal.—*Science Service.*

Explain Storage Changes in Eggs

AN egg deteriorates in storage because it is digesting itself. Recent work by food chemists of the United States Department of Agriculture shows that trypsin, one of the enzymes present in the pancreatic juice of the human body, is present in egg white and is quite probably responsible for the changes that occur in eggs when they are stored for several months. The function of trypsin in the human body is to digest protein foods. Presumably that is just what it does in the egg white.

For years scientists have suspected that trypsin or some other proteolytic enzyme was responsible for two of the important changes that take place under storage—a weakening of the membrane around the yolk, causing it to break more easily, and an increase in the amount of thin white.

The search for trypsin in egg white was complicated by the presence of a substance in the thin white which inhibits any further action of the enzyme. As a result, tests of mixed thick and thin egg white have failed to show the presence of trypsin. The Department chemists next separated the thin and thick white and tested each. They found trypsin then in the thick white without any difficulty.

As a check on their conclusions the investigators took a fresh egg, punched a small hole in the end and injected trypsin into the thick white with a hypodermic needle. Fresh eggs so treated took on in a few hours the characteristics of eggs held in storage for many months. The whites became thin and watery and the yolks became fragile. Within two days it was almost impossible to break the egg without breaking the yolk.

This diagnosis of one of the contributing causes of the changes that take place in storage eggs provides a starting point for further research. Now that the cause is known the next step is to try to find a remedy which may be put into application commercially.

Sodium Lamps Have No Advantage for Close Work

THE new lamps filled with sodium vapor which are gradually coming into use for highway illumination have no special advantages or disadvantages for indoor clerical use. This is the report of Dr. James E. Ives, senior physicist of the U. S. Public Health Service, in announcing the result of a three months' test to learn whether the yellow-glow lamps held special merits for indoor work.

C. W. A. clerical workers served as test subjects for the investigation held in New York City.

By checks on speed and amount of work accomplished, and comparison tests of the eyesight of the subjects before and after

undergoing the test, the following results are reported:

1. Sodium light has no permanent effect on the eyes which could be detected by clinical tests after the subjects had worked for 4 hours a day over a period of 12 weeks in the yellow light.

2. No significant difference in the amount of work performed by the groups of men working under sodium and tungsten lamps could be observed.

While there is a definite gain in economy in using sodium vapor lamps, the single color of the light makes it impossible to perform any type of task dependent on color. Curious effects are obtained when color work is attempted under the yellow lights. On highways so illuminated, for example, green leaves all appear white, and a green field looks as if it were covered with snow.—*Science Service.*

Honeybee as Wild as Ever

THE honeybee is often spoken of as domesticated, but this is far from true. Although men and bees have been closely associated since the dawn of history, the honeybee is apparently as wild today as it was centuries ago.

Other wild animals have yielded to man's influence and many of them are now as dependent upon man as man is upon them; but the bees in apiaries are as wild as are their cousins in dense forests.

Bees taken from a bee tree and placed in a modern hive are as much at home there as though they were descended from generations of hive-raised bees. On the other hand, a swarm that has left a modern apiary and settled in a hollow tree fares as well in its new environment as did any of its ancestors in cave or forest. Bees are no more domesticated than are the bats in the barn or attic.

Bee specialists of the United States Department of Agriculture explain this unchanging trait in bees by stating that the queen and the drone that mates with her—the only bees having the power of reproduction—have no contact with the outside world and therefore have no new experiences to pass along to their offspring. The worker bees, who are constantly subject to new conditions, have no offspring and no opportunity to pass on to future generations the benefits of their experiences.

In recent years bee specialists in the Department of Agriculture have been able to impregnate queen bees by the use of delicate instruments. It is expected that by this method of artificial insemination changes can be brought about in honeybees that will render them still more useful to man. (See September, 1933, SCIENTIFIC AMERICAN.)

Penguins Use Air Conditioning

A LETTER from the Byrd Antarctic Expedition has just been received by the B. F. Sturtevant Company, makers of air-conditioning equipment, advising that the expedition will attempt to bring back from the ice fields live European Penguins in a special air conditioned room on the *Jacob Ruppert.* The Sturtevant Company, which has supplied various equipment for Little America and Byrd ships, has furnished for the purpose blower equipment for distributing refrigerated air throughout the "penguin stateroom," which will measure about 10 feet long, 8 feet wide, and 6 feet high.

THE CHEMICAL INDUSTRY IN 1934

By A. E. BUCHANAN, Jr.

[*The following paragraphs give a comprehensive review of progress in the various fields of chemistry during the past year. Of necessity some of the items mentioned have been described in more detail in preceding issues of* SCIENTIFIC AMERICAN. *Their importance in their own fields, however, makes it necessary to repeat them briefly in order to make the picture more complete.*—The Editor.]

WHILE still showing the effects of the depression when compared with boom years, the chemical industry in 1934 showed a general improvement in production and in profit. This industry has had the distinction of being almost the only basic industry of the country that has come through the depression without any of the major companies in the group reporting a deficit. It was also one of the first industries to show a definite up-turn. The repeal of prohibition was a boon to the chemical companies, particularly the alkali producers because the increased production of bottles called for larger quantities of soda ash. Automobile production stepped up the consumption of solvents, lacquer materials, and glass. The automobile manufacturers have also been responsible for the production of new alloys for special purposes to an extent that indicates that the "age of alloys" is just beginning.

The industry has maintained its research activities, improved its manufacturing processes and the quality of its output, and has developed new and useful products. Thus, for example, improved methods for the manufacture of phenol have made this basic organic chemical available at a much lower cost, resulting in stimulation to the plastic industry. New plastic materials made from phenol are being developed for the building trades and are expected to hasten a revival in that basic field.

Some of the larger corporations disclosed a renewed tendency to broaden their lines and consolidate production by absorbing smaller industrial units as, for example, the American Cyanamid Company, which, during the year, acquired the General Explosives Corporation and the Maryland Chemical Company. Bold confidence in the future of the chemical industry was also revealed by the establishment of six new chemical plants in the south; namely, the Ethyl-Dow Chemical Company, Wilmington, North Carolina; the Southern Kraft Corporation, Panama City, Florida and Mobile, Alabama; the plant of the Freeport Sulphur Company, Lake Grande Ecaille, Louisiana; the Solvay Process Company, Baton Rouge, Louisiana; the Mathieson Alkali Works, Lake Charles, Louisiana; and the Southern Alkali Corporation, Corpus Christi, Texas.

HOME-GROWN PAPER. The results of several years of patient experiment by Dr. Charles H. Herty, looking toward the manufacture of newsprint paper from the wood of the slash pine, native to the southern coastal states, were evident during 1934 when the experimental plant in Georgia proved itself able to operate commercially. For his pioneer work in this enterprise, Dr. Herty was made the recipient of the Charles H. Herty medal, an award which was established a few years ago in his honor and which, appropriately enough, was awarded to him this year as having made an outstanding contribution to chemical research.

OUTSTANDING CHEMISTS OF 1934. Exceptional work in the field of chemistry is recognized by the award of medals, the award usually being named for some distinguished chemist of revered memory. One of the most highly prized of these is the William H. Nichols medal bestowed annually by the New York section of the American Chemical Society, which was, for 1934, awarded to Professor Henry C. Sherman, of Columbia University, in recognition of his achievements in vitamin research.

The Willard Gibbs medal for 1934 was awarded to Harold C. Urey, of Columbia University, for his brilliant work in the discovery of the hydrogen isotope called "deuterium." His discovery supplied the impetus for widespread work on the so-called "heavy water."

The Theodore William Richards medal, bestowed annually by the Northeastern Section of the American Chemical Society, was awarded to Professor Gregory P. Baxter, of Harvard University, in recognition of his achievements in the measurement of atomic weights for which Dr. Baxter has also received the Nobel prize in chemistry.

The Schoellkopf medal for 1934 was awarded to James C. Downs for his work in the development of the Downs sodium cell, in which most of the world's sodium production is now made by the electrolytic decomposition of salt.

Some of the many significant or interesting developments in the field of applied chemistry during 1934 are outlined briefly below:

HEAVY WATER. The newly discovered isotope of hydrogen, "deuterium," which has created so much interest among scientists, was made commercially available during the year by the California Isotope Company, of Berkeley, California, formed specifically to manufacture "heavy water." The capacity of this company's plant is about four grams of pure "heavy water" per week. The "heavy water," which is more correctly known as deuterium oxide, sells for 80 dollars per gram.

GOLD FROM SEA WATER. The extraction of the minute quantities of gold, known to exist in ocean water, was again suggested as a commercial possibility as a result of the success of the unique plant of the Dow Chemical Company, near Wilmington, North Carolina. This plant was erected to extract bromine from sea water, the bromine being in demand because of its use in the manufacture of anti-knock compounds for motor gasoline. It is successfully recovering 60 of the 65 parts per million of bromine which is the average concentration of that element in sea water. The successful extraction of this substance has inspired hopes that some process may be developed for the recovery of the even scarcer precious metal.

GRAPEFRUIT PERFUME. Grapefruit rinds discarded by Florida canners can be used as raw material for valuable essential oils used as flavors and perfumes as a result of experimental work by chemists of the United States Department of Agriculture.

ACCELERATED AGEING OF LIQUORS. The legalizing of liquors and the consequent sudden demand for properly aged whiskey raised a neat research problem for the chemists. Their studies threw considerable light on the mechanism of the mysterious natural process of "ageing" and through these studies they have been able to develop four different methods of speeding up the mellowing process. The four methods involved are (1) treatment with oxygen or ozone, (2) ultra-violet light, (3) electrolysis, and (4) the use of catalysts such as finely dispersed copper, nickel, and titanium.

LARGEST GLASS EYE. The attention of the scientific world was turned toward Corning, N. Y., on March 25, 1934, when 20 tons of molten white-hot glass, at a temperature of 2400 degrees, Fahrenheit, was poured into a mold, 17 feet in diameter, to form the reflecting mirror that was to be used in the world's largest telescope. In August, when the glass was partially annealed, it was discovered that some imperfections were present and preparations were made for casting a new disk.

BETTER CELLULOID. New synthetic products of the glycol ether-ester type have been developed during the year. These synthetized chemicals are used as plasticizers in cellulose acetate and cellulose nitrate, being superior for the purpose because of their stability to light and heat.

TEXTILE LUBRICANTS. A water soluble lubricant for the treatment of worsteds and wool in textile manufacture has been developed. While still somewhat more expensive than conventional lubricants for this purpose, the new substance, perfected by chemists at the Mellon Institute, has the advantage of being entirely miscible with water—a characteristic that eliminates scouring before dyeing—and it gives a yarn that is white and soft.

STAR SPANGLED PAPER. Research into special types of decorative paper for greeting cards, and so on, has produced an attractive novelty consisting of paper with minute metallic particles dispersed throughout the sheet.

INSULATING LIQUIDS. That synthetic organic compounds will soon replace mineral oils as insulation for high-voltage transformers, was forecast in a symposium held by the Electrochemical Society. The absence of sludging and the non-inflammable nature of the vapor are points strongly favoring the new type of insulating material.

LARGE MOLDED VESSELS. Progress in the molding of large items of chemical engineering equipments in single pieces

The Chemical Industry in 1934

(Continued)

from the phenolic resin "Haveg" was described at the main meeting of the American Institute of Chemical Engineers. Using a plastic mixture of resin and asbestos fiber, tanks as large as ten feet in any dimension can be built without seams and with maximum resistance to solvents and corrosives. Pipes and fittings of the same material are also available.

VISUALIZES NEW INDUSTRY. Carleton Ellis, distinguished petroleum chemist, visualized for the American Institute of Chemical Engineers a great new industry based upon the utilization of petroleum compounds which may rival the synthetic chemical industry built upon coal tar derivatives.

GROWTH OF AMERICAN DYES. That the United States is fast becoming independent of foreign sources for synthetic dyes and medicinals was evidenced during 1934 by figures compiled by the United States Department of Commerce, showing a marked decline in the importation of these substances and a healthy increase in Uncle Sam's exports.

PAINT SALES GROW. A healthy increase in the production of paint and varnish was registered during the past year over 1933 when sales touched the lowest level for some time. While industrial sales accounted for a considerable part in the increased business, the major portion was due to customer purchases stimulated by "paint up" campaigns and federal home loans.

OIL EXTRACTION. A continuous process for extracting oil from soya beans, cotton seed, tung nuts, linseed, castor beans, copra, meat scraps, and so on, is expected to revolutionize the standard and accepted process. Not only is the continuous process superior to the old batch process in efficiency, but a higher percentage of recovery is obtained.

PRESERVING SERUMS. A method of preserving life-saving serums for pneumonia, diphtheria, typhoid fever, and so on, so that they retain their potency, was announced by Dr. E. W. Flosdorf before the American Chemical Society. The preserving process involves the removal of 99.9 percent of the water from the serums by freezing them in solid carbon dioxide and removing the water by distillation in a vacuum. The dry, solid serum crystals keep indefinitely and are ready for use when dissolved in distilled water.

99.92 PERCENT PURE IRON. Going Ivory Soap one better, chemists have produced an iron of extreme purity at commercial prices and find that at a purity of 99.92 percent the metal exhibits properties that open an entirely new field of usefulness for iron.

THERMOPLASTIC CEMENT. A new type of cement, water-proof, flexible, resistant to oil and grease and not subject to embrittlement on ageing, was introduced. Heat and pressure are necessary to produce the bond, which is of exceptional strength and applicable to a wide variety of materials.

SPEEDS UP VEGETABLE DRYING. Vegetables may be dehydrated in one third the time usually required by a new method in which the product is revolved rapidly in a draft of warm air, utilizing centrifugal force to throw moisture to the surface. Fruits, meats, fish, and cheese can be dried this way.

RADIOACTIVE TEXTILES. Radioactive fabrics have been woven from rayon made with minute quantities of radium sulphate incorporated in the silk spinning solution. Repeated wearing and washing have no appreciable effect on the radioactivity of the fabric.

NEW TYPE WINDOW GLASS. Corning Glass Company announced a new type of window glass, called Aklo, which passes light but holds back 70 percent of the heat rays.

BUBBLY RUBBER. Said to be the lightest solid substance known, Onazote, a patented insulating material made of "rubber and bubbles" is the most perfect insulator against noise yet developed.

SYNTHETIC ANILINE. Professor Franz Fischer, eminent German chemist, announced a new process for the synthesis of aniline by the catalytic combination of phenol and ammonia. The reaction is carried out under 10 atmospheres pressure and at 450 degrees, Centigrade. The significance of this announcement is the possibility that cheap aniline may be commercially available soon.

IODINE FROM OIL-WELLS. Exhausted oil-wells in southern California are capable of producing sufficient iodine to meet the entire present requirements of the United States. The iodine is present in very dilute solution, but modern methods permit its extraction at commercially feasible cost.

POWERFUL GERMICIDE. A powerful new agent for destroying bacteria which is said to be equally deadly to all types of germs but absolutely harmless to body tissue was reported to the American Chemical Society. The new compound, azochloramid, promises to be a valuable aid in surgery.

"GASSING" FRUIT. Fruit growers and shippers continued to experiment with artificial atmospheres to improve the preservation of their products. Carbon dioxide gas has been found to decrease losses by rot and other diseases during shipment in refrigerator cars. Nitrogen trichloride gas effectively curtails the action of mold spores on oranges during shipment.

NEW POISON GAS. A new type of poison gas discovered by accident was announced to the American Chemical Society by Dr. George H. Cady. Composed of nitrogen, oxygen, and fluorine, the gas is deadly when inhaled and explodes violently when heated.

SALMON-LIVER OIL. Chemists of the United States Bureau of Fisheries discovered that oil extracted from the liver of

salmon contains more vitamins than cod-liver oil. According to their tests, the salmon oil is approximately five to twenty times as potent in vitamin A and twice as potent in vitamin D as cod-liver oil.

METAL-TO-GLASS SEAL. A new alloy called Fernico was developed by the General Electric Company to make possible tight and reliable joints between glass and metal. The expansion curve of Fernico coincides almost exactly with that of certain glasses. Fernico can be machined, forged, punched, drawn, stamped, soldered, brazed, and welded with a facility equal to high-grade nickel iron.

CURRENT BULLETIN BRIEFS

CHEMICAL GUIDE-BOOK FOR 1934. The tenth edition of this useful book of addresses is complete in that it gives even telephone numbers of concerns. It also gives information as to chemicals, including the chemical formulas, physical properties, tariff, and prices. *Chemical Markets, Inc., 25 Spruce St., New York.—$2.00.*

CONCRETE ROAD DESIGN, by Frank T. Sheets, describes the great advances made in the last 12 years in the science of designing concrete pavements. *Bulletin 135A, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

THE BAKELITE REVIEW is a periodical digest of Bakelite achievements interesting to all progressive manufacturers and merchants. *Bakelite Corporation, 247 Park Ave., New York, N. Y.—Gratis.*

LINK-BELT ROLLER-CHAINS (Data Book 1457). In this book the proper selection and application of finished steel roller-chains and wheels are described for the fields of usefulness to which they are best adapted. There are many excellent tables. *Bulletin 135B, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

BUILDING THE MUSEUM GROUP (Guide Leaflet No. 82), by Albert E. Butler, describes how the groups are made in our great museums from the foundation to the finished product. All the accessories are described and the method of fabrication is described.—*American Museum of Natural History, 77th Street and Central Park West, New York City.—15 cents.*

WOOD WORKING PRODUCT MANUALS deal with circular saws, files, machine knives, and "carboloy" products. State what you are interested in. *Bulletin 135C, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

THE COMPARATIVE LIFE, FIRE, AND EXPLOSION HAZARDS OF COMMON REFRIGERANTS gives a comprehensive report on the explosion hazards of common refrigerants. There is of course no hazard presented as long as the refrigerant is confined within the mechanical system. The properties constituting the hazard of the refrigerant are those relating to its toxicity, its flammability and explosiveness. The report was made by the Underwriter's Laboratories and the tests were exhaustive. *Kinetic Chemicals, Inc., Wilmington, Delaware.—$2.25.*

GUARDITE describes how the problem of insect infestation can be prevented either in food products or tobacco. *The Guardite Corporation, Chicago, Illinois.—Gratis.*

THE YELLOW STRAND, Volume 59, Number 4, describes the deepest well in the world, 11,377 feet deep in which an enormous quantity of wire rope was used. *Bulletin 135D, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

THE DU PONT COMPANY AND MUNITIONS is the title of a 42-page booklet that gives the essential facts of the du Pont Company's position with respect to the manufacture and sale of munitions of war. *Stockholders' Relations Division, du Pont Company, Wilmington, Del.—Gratis.*

THE SHARPLES SUPER CENTRIFUGE IN INDUSTRY refers not to a particular machine but to a family of machines. Each type within the family is unique in that it is specially designed to accomplish most effectively a specific centrifugal operation. This pamphlet gives sectional drawings of the devices, and pictures of installations. *Bulletin 135E, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

WIRE ROPE by Wickwire Spencer gives some excellent hints on the use and treatment of wire rope (Catalogue No. 128). *Wickwire Spencer Steel Company, 41 East 42nd St., New York City.—Gratis.*

VINYLITE, THE VERSATILE PLASTIC describes a resinous material that can be formed by heat and pressure into almost any desired shape and color. *Bulletin 135F, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

SYNTHETIC ORGANIC CHEMICALS. Information regarding certain of the characteristics and uses of these synthetic compounds has only recently become available. The data suggests new uses. *Carbide and Carbon Chemicals Corporation, 30 East 42nd St., New York, N. Y. Gratis.*

IT PAYS TO OWN A FIREPROOF HOME—HERE'S HOW IT'S BUILT. A well illustrated pamphlet giving details of construction of houses, terraces, swimming pools, et cetera. *Bulletin 135G, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

LITTLEFORD ROAD MAINTENANCE AND CONSTRUCTION EQUIPMENT (Catalogue J) describes machines for spraying, surface heaters, and distributors, as well as metal pots and the miscellaneous tools used by asphalt workers. *Littleford Bros., Cincinnati, Ohio.—Gratis.*

Books SELECTED BY THE EDITORS

APPLIED OPTICS, Vol. II

By L. C. Martin, D. Sc., A.R.C.S.

THE first volume of this work appeared several years ago but the second, now published, may be obtained and used separately without any embarrassment. Alan R. Kirkham, of Tacoma, to whom the review copy was forwarded, writes concerning it: "This is probably the most usable and practical book on optics ever written for the amateur telescope maker, because it is entirely about telescopes and microscopes, instead of giving merely the usual one or two sketchy chapters. If you want to know the right way to design an achromatic objective; if you are puzzled over anything about telescopes; or if you merely want to use optical instruments intelligently, you can do no better than to obtain it. In most cases, knowledge of arithmetic is all that is needed, along with the ability to understand formulas. There is no deep mathematics. The book is not exhaustive, but is fully bibliographed so that one may pursue any branch further."—$6.20 postpaid.

ELECTRONS AT WORK

By Charles R. Underhill, E.E., F.A.I.E.E., F.A.A.A.S.

WHILE many people undoubtedly think of vacuum tubes mainly in connection with radio receivers, there are an increasingly large number of industrial applications of these facile instruments. The present book is designed to give the reader not only a comprehensive background of the subject of electronics but also a fundamental knowledge of the varied applications of all types of vacuum tubes. The make-up of the book is such that these applications are segregated in separate chapters and are treated at length. Thus the reader can refer directly to any one or more specific phases of electronic tube use and will find at his finger tips most of the available information.—$3.20 postpaid.—*A. P. P.*

ELECTRON TUBES IN INDUSTRY

By Keith Henney, Associate Editor, Electronics

WHILE this book covers approximately the same ground as "Electrons At Work," by Charles R. Underhill, it is more advanced in its treatment. Although the fundamentals of electronic circuits are given in the opening chapter, the author presupposes that the reader has a thorough background in electricity. The text gives a complete presentation of the more practical aspects of electronic tube applications and describes in detail various types of tubes and methods of using them for producing desired results. The chapters dealing with photo-electric tubes are to be especially recommended. The first of these tells in detail of the various types of photo-cells while the second chapter describes their applications to various industrial purposes. This book will be of great assistance to the industrial engineer, and to the more advanced student of practical electricity. Well illustrated with charts and diagrams which amplify the text, and supplemented by an excellent index.—$5.20 postpaid.—*A. P. P.*

CONFESSIONS OF A SCIENTIST

By Raymond L. Ditmars

DR. DITMARS is a well-known scientist whose main job seems to be in the tropics collecting specimens for his reptile house in Bronx Park, although he is also chaperone among other things to a family of ill smelling and pestiferous small mammals. He recounts many of his adventures in this book, such as the story of the first vampire bat which he captured in a murky tropical cave and which he was enabled to exhibit alive. Dr. Ditmars writes interestingly always, even of his experiences on the lecture platform when his "exhibits" sometimes get away from him. Withal a sense of humor pervades the book whether he deals with the Loch Ness Monster, a white rattlesnake, or only a tree frog.—$3.65 postpaid.—*A. H.*

AUTOMOBILE SERVICE SHOP MANAGEMENT

By C. Edward Packer, B.C.S., and J. A. Ahlers, M.E., B.C.S.

HERE is a book written for the specific purpose of training the reader in a definite business. It begins with the consideration of servicing automobiles on a practical basis and takes up such things as starting the business, possible income, financing, management, merchandising, and advertising. These various points are taken up in detail and give the best possible leads to the operation of a satisfactory business arrangement between the service station manager and the public. Equipment and its arrangement are given considerable space and the book is completed with a check list of all the things that are needed in an up-to-date and completely equipped automobile service station. The book will be found valuable not only by those who are contemplating going into this particular field but also by service station managers and employees who have ambition enough to want to keep abreast of the times. $5\frac{1}{2}$ by $8\frac{1}{2}$ inches, nicely printed on heavy stock, 150 pages.—$1.65 postpaid.—*A. P. P.*

THE NEW WORLD OF SCIENCE

By A. Frederick Collins

THE inspiration for the present book was obviously furnished by the recently closed Century of Progress Exposition in Chicago. In fact, almost the whole book is devoted to the description and analysis of the many marvels of science which were on display at that Exposition. In one or two cases the author breaks away from the World's Fair and injects something about other scientific developments. If you visited the Century of Progress, this book will undoubtedly tell you of many things that you missed. If you were not fortunate enough to have been able to attend this Exposition, the book will to some extent make up for this failure. $5\frac{1}{2}$ by $8\frac{1}{2}$ inches, 308 pages, with a comprehensive index. Thoroughly illustrated with drawings and photographs. — $2.70 postpaid.—*A. P. P.*

EXPLORING WITH THE MICROSCOPE

By Raymond F. Yates

THIS is a practical book for the beginning microscopist. In a chatty, friendly style it tells how to go at the hobby in a simple manner and, taking its reader by the hand, conducts him along some of the paths of fun the hobby affords. Anyone who does the various stunts this book describes will have a barrel of fun and can follow up with more technical books later on.—$2.15 postpaid.—*A. G. I.*

SHORT WAVE RADIO HANDBOOK

By Clifford E. Denton, B.S., E.E., M.E., M.A.

FOR the radio enthusiast who is particularly interested in short-wave set construction or in the improvement of his present equipment, this book will

prove to be a gold mine of technical information. The author has avoided as much as possible any complicated mathematics and has drawn upon a comprehensive background of experience. The book is compact—6½ by 8½ inches—contains 128 pages, lavishly illustrated with pertinent drawings and illustrations. Data are given which will enable the reader to construct various types of experimental receivers, and what is more important, learn how to operate them. Throughout the book are scattered numerous tables giving information which is usually difficult to find elsewhere.—$1.00 postpaid.—*A. P. P.*

CHALLENGE TO THE NEW DEAL

By 35 different writers

IN this book the New Deal is challenged not, as one might possibly conclude, from the right, but from the left. It is no conservative Republican (or Democrat) who does the challenging but 35 radicals, and their challenge is based on their assertion that the New Deal does not even go far enough. Readers who are curious to know what Max Eastman, John Dos Passos, Philip La Follette, Upton Sinclair and so on, want done to the rest of us, will find it in this book. At that it is a pretty sane presentation—as such things go. Particularly so is the chapter by the Treasurer of South Dakota, Alfred S. Dale, entitled "Radicals Give Me a Pain in the Neck," which must have been included because the radicals who will mainly read the book ought to hear it. This book tells what is going to happen next in the U. S. A.—if you believe everything you hear, and are inclined to have nightmares in the daytime.—$2.70 postpaid. —*A. G. I.*

THE ADVANCE OF SCIENCE

By Science Service Writers

THIS book is packed with short, well-written, authoritative accounts of scores of recent developments in science and industry, ranging from cosmology, through atomic physics and the biologies, to anthropology and other sciences. It is a valuable record of current scientific and industrial advance, written mainly by half a dozen Science Service writers and edited by the capable director of the same organization.—$3.70 postpaid.—*A. G. I.*

THE GREAT DESIGN

Edited by Frances Mason

MRS. MASON, who is in love with the concept of a divinely directed universe, and order and progress in nature, has prevailed on several men of science having similar leanings, as well as some others, to contribute chapters to this book, and it makes most interesting reading. The late J. Arthur Thomson contributes the introduction, J. P. Crowther of Cambridge writes on radiation, A. S. Eve of McGill writes in a philosophic vein about the universe as a whole, the seismologist Baily Willis discusses the earth as the home of man. Lloyd Morgan writes on the ascent of mind, MacBride the English biologist on the oneness and uniqueness of life, Gager the Brooklyn botanist on the plant world, Metcalf of Oberlin sees design and purpose in the universe, Younghusband finds mystery in nature, while Fraser-Harris finds in it not mystery but unity and intelligence. Driesch believes there has been a breakdown of materialism and says so, while J. Arthur Thomson writes concerning the wonder of life. For those who lean toward mysticism in science, this book will be a rare collection of encouragement in that direction. $2.70 postpaid.—*A. G. I.*

SCIENCE FOR A NEW WORLD

Arranged by J. Arthur Thomson, J. G. Crowther, Editor

THE late Sir J. Arthur Thomson, noted popularizer of science, planned this book and was able to obtain as contributors to it 15 of the world's ablest men of science, each of whom contributes a chapter. For example, Hogben writes on heredity and human affairs, MacKenzie on medicine, Eve on the trend of physics, Dingle on astronomy, Birkhoff on mathematics, and others on anthropology, biology, psychology, sociology, theology and science, chemistry, logic, and philosophy. These are all essays, largely philosophical in nature, on the new sciences, and the sum is a notable book.—$3.95 postpaid.—*A. G. I.*

MY BODY AND HOW IT WORKS

By Dorothy Baruch and Oscar Reiss, M.D.

THIS little book is a physiology, very elementary and in story form, for youngsters of about 9 to 14. Its authors are respectively assistant professor of education at Whittier College and chief of the pediatric staff of Los Angeles County Hospital, and their book has been strongly endorsed by prominent child health specialists and professors of pediatrics in leading universities. Different child dialogs, very clever and witty, bring out "what happens" when you eat, when your heart beats, when you breathe, when you see and hear things, and so on. Reading on, one wonders how this book, so widely recommended by modern educators, will deal with reproduction. It deals with it frankly, telling things in the way that is now being recommended by best authorities—that is, plainly giving the real names of things, instead of using the various subterfuge words, always suggestive because they were subterfuges, which we oldsters were taught to use in an uncandid generation. A little book which deserves a big niche.—$1.65 postpaid.—*A. G. I.*

CHEMICAL ENGINEERS' HANDBOOK

John H. Perry, Ph.D., Editor in Chief

THIS timely handbook contains 2609 pages filled with practical suggestions for the construction of chemical equipment. The 30 sections deal with such subjects, for example, as distillation, absorption, mechanical separations, crushing, grinding, and pulverizing, movement and storage of materials, fuels, mechanical and other power transmissions, refrigeration, electrochemistry, accounting and cost finding, safety and fire protection. The illustrations, while small, illustrate the text admirably. No chemist should be without this book and for the chemical engineer who really builds plants it is indispensable. It is needless to say that there were many contributors—63 in all.—$9.35 postpaid.—*A. A. H.*

LIBERIA REDISCOVERED

By James C. Young

NOW that Harvey Firestone is preparing to produce rubber in our de facto protectorate, Liberia, every well informed American will want to become posted on that land and the Firestone development, since both will come to the front increasingly in the next few years. This book contains in readable form all the information the average man would be likely to ask for in order to understand Liberia.—$1.65 postpaid. —*A. G. I.*

THE TWILIGHT OF PARENTHOOD

By Enid Charles, Ph.D.

THE author of this alarming book believes, as do many others, that the western world may soon decline in population because of changing social conditions which have altered our attitude regarding parenthood. Just why a smaller population will be a detriment to the world we shall leave to the reader to figure out—the author evidently takes it for granted.—$2.65 postpaid.—*A. G. I.*

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ACROSS THE EDITOR'S DESK

A Job for Everyone

EVERYWHERE people are talking about building. The National Housing Program has gotten underway, with the durable goods industries expected to lead the way back to a permanent prosperity. James A. Moffett, housing administrator, has set a goal of 5,000,000 re-employed, one billion five hundred million dollars spent by private citizens for housing improvements.

The government has left the success of the program pretty much up to the industries and to the people. In hundreds of cities local better housing programs are underway with many more in a formative state. Booklets explaining the program have been circulated by building manufacturers. Radio programs, magazine advertising, and direct mail services have publicized the act. Three great organizations, Johns-Manville Corporation, manufacturers of everything in the building line from asbestos shingles to wall insulation; Sears-Roebuck, giant mail-order house; and the American Radiator Company, have all set up separate credit corporations supplementing and co-operating with banks in extending credit to home owners. Contractors are paid by these manufacturers who in turn are paid over a long time period by the home owner.

Some of the largest manufacturers of housing materials are planning to send out motorized display caravans which will tour the country demonstrating their products where the material is actually to be used. The companies which have thus far signified their intention to take part in the plan are the Johns-Manville Corporation, American Radiator and Standard Sanitary Corporation, General Electric Company, Westinghouse Electrical and Manufacturing Company, Armstrong Cork Company, Sherwin-Williams Paint Company, Crane Company, Weyerhauser Lumber Company, and Alexander Smith and Sons Carpet Company.

Just what *are* the housing conditions in the United States? We built during 1934 less than 50,000 houses. With a population of over 120,000,000, this is a poor showing against England's 300,000 houses built in 1934, and their population is only one third of ours. No central heating plants are possessed by 72 percent of our city dwellings; 29 percent have neither bathtub nor shower; 38 percent, no facilities for hot water; and 36 percent cook without gas or electricity. Of the 29,000,000 buildings in this country, 16,000,000 are in need of repair, 3,000,000 of these being so badly depreciated as to be unfit for human habitation. The Governmental estimates of the present housing shortage in this country as being 1,750,000 houses is indeed very conservative, but beyond this detail there is the added necessity for tremendous repair operations and for the addition to present homes of heating and sanitation equipment.

From a Letter to the Editor . . .

". . . Construction of homes—really livable homes with adequate provision for creature comfort and health—is the aim of this department. In this work, which will go far toward rehabilitation of many industries throughout the country, widespread publicity of aims and policies is essential . . ."

JAMES A. MOFFETT
Federal Housing Administrator

It has been said that could we but start a great activity in this line, we would then have found the key which will unlock the door to future prosperity. The start has been made and SCIENTIFIC AMERICAN will in future issues lend its full support to the movement in a series of articles pointing out pertinent facts regarding housing conditions in this country today. In hand already is an article by Dr. Haven Emerson, President of the American Public Health Association and Professor of Public Health at the College of Physicians and Surgeons at Columbia University, concerning mainly the appalling lack of sanitation in thousands of homes and the resulting effects on health. This will be published shortly.

Editor and Publisher

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

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COVER

A RECENT development by the sound engineers of the Bell Telephone Laboratories is the 500-watt loudspeaker for marine use, described on page 92 of this issue. The voice pick-up is shown on our cover.

The SCIENTIFIC AMERICAN DIGEST

Books SELECTED BY THE EDITORS

AMERICAN MEDICINE

By Dr. Henry E. Sigerest

OTHER popular books have covered the growth of world medicine but on such a scale American medicine does not figure predominantly. This book is devoted wholly to the rise and progress of American medicine, peculiarly. The author is professor of the history of medicine at Johns Hopkins University and is the author of a recent popular book entitled "The Great Doctors." His books are distinctly human and readable.—$4.20 postpaid.—*A. G. I.*

NAVAL CUSTOMS, TRADITIONS AND USAGE

By Lieutenant Commander Leland P. Lovette, U. S. N.

THE groundwork on which this book depends was a series of lectures given to a group of student officers at the Postgraduate School, Annapolis, Maryland. The book comprises a special course in customs, traditions, social usage, and regulations pertaining to honors and ceremonies. It is a book which will be warmly welcomed to the lay library for it has a distinct literary flavor. The illustrations, while not many, take us from George Cruikshank to Zogbaum. The technical side dealing with such subjects as precedent, solutions, et cetera, are impeccable. The book is filled with much out-of-the-way information conveyed in an interesting manner. —$3.75 postpaid. —*A. A. H.*

INDUSTRIAL ELECTRONIC TUBES

A NON-MATHEMATICAL treatment of the uses of all types of electronic tubes in industry. Reproduced by the zincograph process from type-written copy, this 217 page volume is copiously illustrated with photographs, charts, and tube circuits. Paper covers, with sturdy cloth backbone; 8¼ by 11 inches. The essential purpose of this thoroughly practical book is to place before the reader the physical properties of all electron tubes—photo-cells, rectifiers, oscillators, amplifiers, ignitrons, X-ray tubes, cathode-ray tubes, glow lamps, and so on—and their possible applications.—$2.40 postpaid. Manual of Experiments with Industrial Electronic Tubes, supplementing the above book and going still farther with practical applications.—75 cents postpaid.—*A. P. P.*

WILD FLOWERS

By Homer D. House

THIS is a book for identifying the wild flowers that grow by the wayside and in the woods. Of such books there have been many but this one is distinguished by the fact that it is the most ambitious piece of fine flower book production ever accomplished. Not only is it a large volume (1½ by 9 by 12 inches, 105 ounces) handsomely bound, but nearly all of its illustrations of plants—364 of them, to be exact—are in full color and many of them full size. The geographical range is the United States, and on thumbing it through we recognize scores of flowers we have seen growing wild, for the illustrations are as good as the flowers (or even better!). Descriptions accompany each plate. It is difficult to see how this book can be produced at the price given, except that a large sale throughout the nation must be expected.—$8.00 postpaid.—*A. G. I.*

FOOD AND HEALTH

By Henry C. Sherman

"THIS book is the result of an attempt to crystallize the best from the voluminous findings of recent years, and especially seeks to convey a sound sense of proportion; first, as to sanitary safeguards in which the vigilance of the consumer should supplement and help to make fully effective the pure food laws; second, as to true economy in the budgeting of the food money; third, as to how far the principles of nutrition are valid for all and how far they are modi-

(*Please turn to page* 111)

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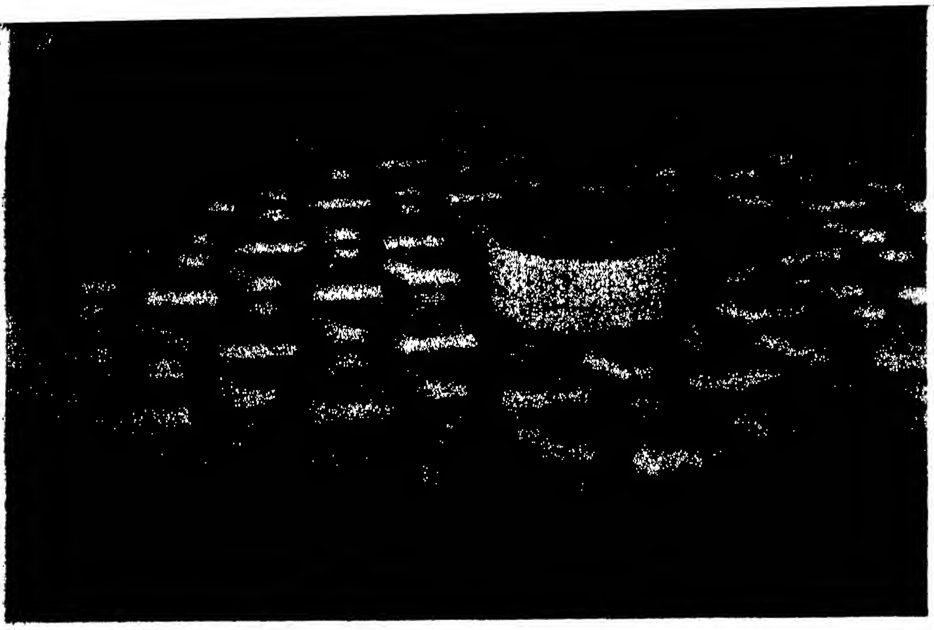
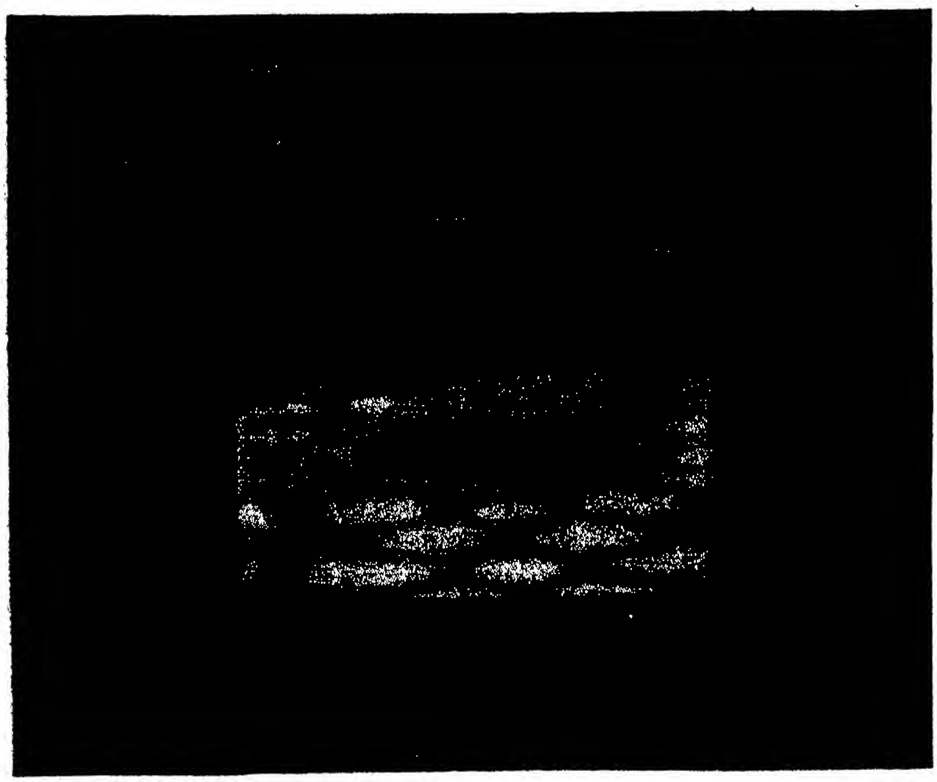
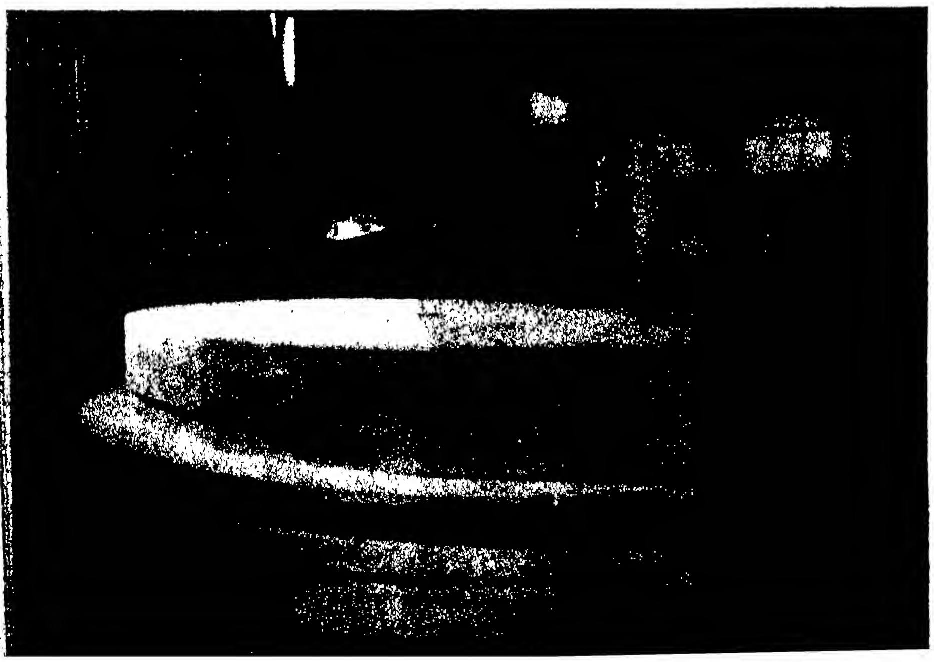






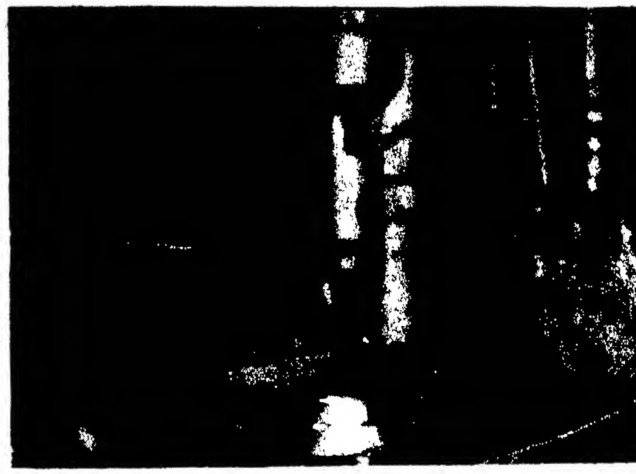
CASTING THE WORLD'S WIDEST EYE

A PERFECT 200-inch disk of Pyrex glass for the world's largest telescope has now been cast at Corning, New York, by the Corning Glass Works. The upper photograph shows the mold of refractory brick with its large core which provides the central perforation needed for the Cassegrain type of telescope; also the 114 smaller cores which give the back part of the disk a hexagonal system of ribs in order to lighten it from 40 tons to about 18.

It was fascinating to watch the result when the first 400-pound ladles of molten glass were poured on this complex of cores. These resemble metropolitan buildings with canyon-like streets between. Pyrex brand glass has a high softening point and at the 2800-degree temperature which was the highest practicable it could not be brought to the consistency of water or even to that of molten iron. At best, though bright red hot, it was but "molasses in January," a very cold January at that, and the poured glass crept down the "streets" with great deliberation. It was kept hot in the covered mold by gas flames until about 100 ladles full had been added, and finally it overflowed the cores and crept up toward the top of the central core, when the pouring was stopped. There, after cooling a few hours, it most resembled the ice in a skating rink, but the skater would have required asbestos underwear, to say the very least, since the real temperature was still above 1000 degrees. The white spots in the middle photograph lie over the tops of the buried cores, the darker areas being above the deeper ribs.

Below is the 200-inch disk cast a year ago. Now that it is stone cold, it is as blue and "deep" as the turquoise Mediterranean.

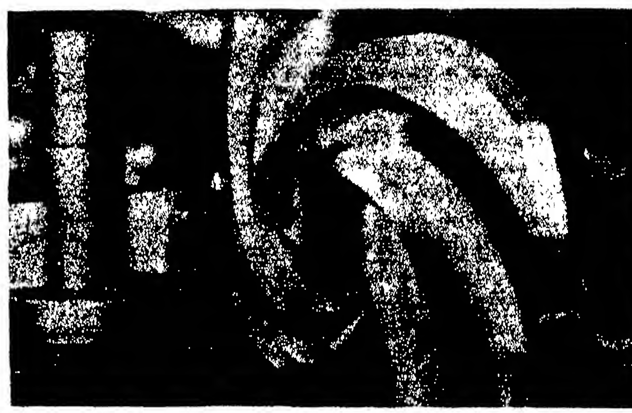
Brass shower heads in fast production



Spot-facing zinc casting at a saving

Machining "non-machinable" alloy pistons

Withstanding the jolts of "jump-cutting"



Photographs copyright Carboloy Company, Inc

CEMENTED CARBIDES IN INDUSTRY

INCREASE PRODUCTION!

Cemented Carbides . . . Near Diamond Hard . . . Tantalum, Tungsten, Titanium . . . Face Tools and Dies . . . Reduce Rejects . . . Permit Fabrication of "Non-Machinable" Products

By PHILIP H. SMITH

SAVINGS of millions of dollars are accruing annually to industry through the use of cemented carbides for dies, tools, and wear-resistant parts. And this is only a beginning. These metallic substances of near-diamond hardness have virtually revolutionized the drawing, extruding, cutting, and machining of metals in mass production by making possible an extraordinary stepping up of operating speeds with marked improvement in quality.

The consumer is the gainer as well as industry. It may be seriously questioned whether the present-day, low-priced automobile could feature such excellent quality were it not for the cemented carbides. Certainly their use in machining operations has made possible the absolutely safe wire wheel and smoother operating engines. And among other contributions, for example, these carbides have enabled the placing of the so-called zipper fastener within the buying range of millions by decreasing the cost of drawing the wire of which these fasteners are made; and the drawing of enough molybdenum wire to satisfy America's insatiable demand for radios.

Cemented carbides, much as the name implies, are carbide particles cemented together, cobalt, and sometimes nickel, being used as the binder. The carbides used are those of tungsten, tantalum, titanium (and rarely molybdenum. As finished products, their applications in three main fields are as follows:

Dies—for drawing and extruding wire, rods, and tubes.

Tools—for machining and cutting ferrous, non-ferrous, and non-metallic materials.

Parts—for wear and corrosion resistance on machinery and equipment.

Tungsten carbide, father of them all, has a history running back 40 years. Henri Moissan was the first investigator; Schroeder of Osram Lamp Works (Germany) was the first to make it commercially important. Schroeder, seeking a substitute for the diamond to draw tungsten filaments, hit upon the

Copyright Carboloy Company, Inc.

Counter-boring fiber clutch facings. Carboloy tools increased machine capacity 36 percent

fused carbide. This was not very practical because only small lumps were obtainable; and then, 13 years later, he succeeded in producing the present-day cemented type which came on the market following an alliance with Krupp. In 1928, tungsten carbide was introduced to the United States for dies and tools, and die application got away to a lightning start.

TUNGSTEN carbide alone is extremely brittle and, in order to apply it commercially, the particles are cemented with cobalt to form a tough bond. The process of manufacture begins with firing tungsten and carbon to make tungsten carbide, then ball-milling particles of it with cobalt until the whole resembles talc powder in fineness. This powder is fired in a hydrogen atmosphere, allowing for a uniform shrinkage of about 16 percent, to produce a material like chalk which can be shaped, allowing for a further shrinkage of some 15 percent in the hardening process. This formed piece is fired at a much higher temperature to emerge in its final form, harder than anything but the diamond with the exceptions of silicon carbide and boron carbide, neither of which has the strength of tungsten carbide.

It is for dies that the cemented carbides have been most extensively exploited. In six years since their introduction they have replaced steel dies for 80 percent of the nation's wire-drawing operations. Cemented carbides have swept through this field because they make die costs per ton of wire more nearly a constant, because they impart a better surface finish and greatly reduce rejections of wire due to off-size, and because they raise productivity per man. The story of achievements with these dies is fantastic; we can do little more than hint at it with random examples.

The drawing of steel wire is now a continuous process. Lengths of wire in the various stages of reduction can be welded to each other and run through the dies for weeks and even months without stopping. With the old steel dies the process was intermittent because dies wore out quickly and had to be replaced, else the gage at the beginning and end of a run would vary, with consequent rejections for being off-size. Speed of drawing varies, of course, with the size and analysis of the steel drawn, but in several instances speed has been tripled.

Cemented carbide dies have been saving an average of 20 percent in time and labor in drawing copper and brass, while with bronze the gains are even greater. Steel dies wore out quickly when handling bronze; hence only relatively short lengths could be drawn and that meant higher production costs.

These dies are being used for drawing welded and seamless tubing, rods, rounds, shafting, and shapes such as squares, hexagons, keystock and keystone, as well as wire. It is now possible, for example, to take a round stock and draw it into a hexagon or square in one operation. Savings from this simplification have been known to amount to as much as four dollars per ton. This single drawing means that a maker of bolts can buy rounds and draw hexagons through a die without the preliminary rough-shaping to a hexagon before drawing.

Trolley wire affords another striking example of what cemented carbide dies have accomplished. This wire must be drawn in lengths of not less than a mile. Steel dies tore the surface before the mile drawing was completed and heavy rejections had to be made because of the poor surface finish. Today, trolley wire can be drawn continuously, using four dies; and while not usual, it is not uncommon for as much as 1000 miles to be drawn to size with one drawing.

Automobile manufacture has benefited in a number of ways. Valve springs, formerly drawn with heavy rejections due to failure to produce a spring with proper vibration frequency, can now be turned out as simply as fence wire for the mechanical properties can be controlled throughout the drawing process. Valve stems, another item demanding accuracy if engines are to give fine service, are now drawn to the number of 500,000 with a single die, whereas 1000 was about the limit with a steel die.

SUCH a little thing as a screw base for an electric lamp doesn't seem like a problem of drawing, but it is. It must be absolutely to size. Steel dies could draw about 200 per minute, last about five hours, and then 20 minutes had to be spent making a new die setup. This meant about 60,000 bases per die. Now a cemented carbide die draws millions. There is one tungsten die that has been drawing for three years and when last heard from had produced 47,000,000 bases.

If there is any question left as to why tungsten carbide has penetrated the wire-drawing field so thoroughly, the reader has only to glance at Table 1. There he will find more data telling the fantastic story. In every case, cemented carbides have brought closer tolerances, reduced scrap losses, improved the product, and lowered the over-all die cost despite the higher original cost.

Examination of what the cemented carbides have done for machining and cutting tools reveals a wholly different picture, but still one of reducing production cost drastically. When carbide dies were introduced they were adaptable to existing wire-drawing machinery. Carbide tools were not quickly

Table 1

Cemented Carbide vs. Steel Dies*
Performance Comparison

Material	Tolerance allowed (inches)	Pounds output per die, ratio steel to cemented carbide	Percentage decrease in rejections
Low carbon spoke wire (wheels) .243 in.	.001	1 : 1240	99
Bessemer screw stock (round) .4375 in.	.002	1 : 840	79.16
Bessemer screw stock (hexagon, sharp corners) .4375 in.	.002	1 : 660	97.5
Fine wire (steel screen cloth) .010 in.	.0003	1 : 130	96.6
Tire bead wire .017 in.	.0003	1 : 200	90

*Analysis by Union Wire Die Corp.

Table 2
Cemented Carbide Tools vs. Steel Tools*
Average Performance Comparison

	Steel	Cast iron	Aluminum alloys	Copper Brass Bronze	Non-metallic materials
Average percentage speed increase	115	153	238	297	175
Average ratio of tool life between grinds	12 : 1	29 : 1	32 : 1	36 : 1	30 : 1

*Analysis by Carboloy Company, Inc.

adaptable, however, because existing equipment lacked the rigidity needed for the higher permissible operating speeds. These conditions made for slower adoption, but results are quite as striking as those obtained with dies. In one sense, therefore, the tool application caused a greater revolution in practice.

The cemented carbides are used for the tips of tools and the introductory type were single point for simple truing, boring, and facing operations, mainly on cast iron. Since that time development has run two courses: creating new alloys (introduction of tantalum, for example, which was found to handle certain steel applications better than tungsten); and, secondly, perfecting the technique of use—as, for example, improving the quality of brazed joints and increasing the variety of steel shanks permissible. The stage has now been reached where the most intricate multipoint tools are practical for all types of machining operations on ferrous, non-ferrous, and non-metallic materials, and even for some operations hitherto un-machinable. Plastics which, oddly enough, tore old style tools to pieces, can now be machined with ease.

THERE are many reasons for adoption of cemented carbide tools. They will cut at terrific speeds and for a long time at red heat without dulling. This is of utmost importance because it means faster feeds and longer cutting life between grinds. Formerly, sufficient surplus material had to be included in castings to permit old-style tools to cut under the scale, but with these new tools light cuts can be taken through the tough scale, and this reduces the amount of scrap. A further saving is obtained frequently due to the ability of cemented carbide tools to combine roughing and finishing cuts in a single operation.

It is almost axiomatic that the mass production industries, where machining of thousands upon thousands of pieces is a major operation, should be the ones to make fullest use of cemented carbides. And that is the case. The automotive industry is the examplar; others are only runners-up, though coming fast. Savings to this industry or to any others cannot be totalled in exact figures, but the possibilities of savings inherent in the carbides are clearly indicated in Table 2, which covers the performance of 100 machining operations selected at random.

Wear-resistant applications of cemented carbides. Micrometer and other measuring instruments fitted with hard wearing surfaces

Turning to specific examples of performance, there are cases of operations hitherto un-machinable, such as: turning 50 chilled iron rolls (600-700 Brinnell hardness) at a saving of 761 dollars over former grinding costs; and the grooving, reaming, sawing, and turning of silicon-aluminum pistons. As examples of marked savings, there are: 1, the use of cemented carbide tools in the counter-boring of fiber clutch facings, thereby increasing machine capacity 36 percent and saving $51.75 between each tool grind; 2, a ninety-five-hour greater production per tool grind obtained in the forming of brass shower heads; and 3, the handling of 718 percent more pieces per tool grind in the facing and turning of semi-steel spur gears, with a 47 percent decrease in machining time, to give a net saving of 400 dollars per 100 pieces. Such performance records afford the best possible explanation for the rapid growth of carbide tool use.

It is wholly logical that cemented carbides should be brought forward for wear and corrosion-resistant parts, following the performance they made in dies and tools. Not much has been done in this third and last field of exploitation as yet, but the following examples give a hint of application scope:

IT has long been a problem for the manufacturer of rayon to get a material for guiding the threads which will resist the abrasive action of the titanium dioxide in the acetate yarns. Glass cuts through within a very short time and so do semi-precious gems. Here, cemented carbides have been put into use with excellent results. Again, in mixing highly abrasive white lead in the manufacture of paint, producers have been greatly hampered. But now, capping the fingers of the rotor and stator in the mixing machines with cemented carbides reduces wearing to almost nothing, and the paint-bleaching operation formerly necessary when wear of metal discolored the lead, has been eliminated.

Cemented carbides have been used successfully for the coating dies used for coating rubber on automobile tire

Copyright Carboloy Company, Inc.

Facing and turning semi-steel; 718 percent more pieces per tool grind

Turning steel rolls with cemented carbide tool; formerly these rolls could be machined only by grinding

bead wire, for coating flux on welding rod, for wire guides, coiling points, and pitch tools in the manufacture of spring wire, washers, etc., and for valve stems and seats on hydraulic presses where pressures range from 25 to 2000 tons.

Blast nozzles provide an excellent example of wear-resistant application. The slightest enlarging of the nozzle orifice through wear adds enormously to the amount of compressed air needed. Consequently wear necessitates use of more compressors and runs up costs. Cemented carbides have been responsible for immediate savings when applied in this manner and are now coming into wider use.

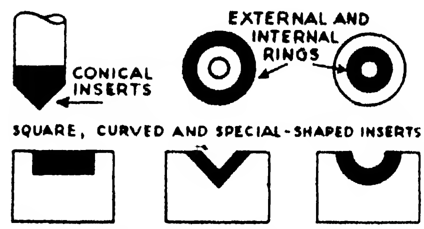
Just how widely cemented carbides have come into industrial use must be judged by the foregoing since statistical data cannot be had. The carbides stem from Schroeder's patents and being closely held, figures of tonnage or value are not published. It is known that approximately 80 percent of all wire made in this country is drawn with cemented carbide dies. It is also known that about 10 percent of possible tool applications have been made and that the use in wear-resistant parts is only just beginning. From this it can be concluded that cemented carbides have made a definite place for themselves in industry and that their greatest development lies in the future. They have revolutionized the handling of ordinary materials of production; they have made possible mass utilization of special alloys; and they challenge the research world to bring forward new, tougher materials.

Price, always a potent factor when it comes to replacements or to the adoption of something relatively new, must be reckoned with in any consideration of what lies ahead. In the case of dies, price is less a factor than it is with tools and wear-resistant parts, since wire drawing is a quantity production operation, whereas there are many tool operations or operations involving great wear where quantity is insufficient to warrant the higher cost of the cemented carbides. The introductory price of tungsten carbide was roughly 400 dollars per pound; today it is about half that. Tending further to broaden the possible market, better technique has led to substantial reduction in the amount of carbides needed for any given tool.

IT seems likely that tool cost will drop more as use increases. And use will increase unquestionably as merits become better known, as the technique of fabrication makes feasible a greater variety of tools, and as modernization of machine tool equipment permits getting the most out of their use. These are developments which quite logically progress together. But this reasoning does not apply quite as well to the future of wear-resistant parts. Their future is somewhat tied up with an uncemented carbide, boron carbide, introduced only a few months ago under the trade name, Norbide.

Norbide is not the first boron carbide ever made, but it is claimed to be the first graphite-free, commercially practical one to be introduced to industry.

In powdered form, this hard substance serves as an abrasive, while in molded form it resists abrasion. It was offered to industry promptly in the form of sandblast nozzles, thread guides for rayon manufacture, and extrusion dies for graphite, porcelain, and other abrasive materials. So the cemented carbides have a competitor. But it is interesting to note that powdered Norbide is being used in place of diamond dust for grinding and lapping objects made with tungsten and tantalum carbide. Thus, the new product, while threatening competition with the cemented carbides for a share of the market, also facilitates their use.



A few general types of cemented carbide inserts commonly used in tools

The part this new product will play in the wear-resistant field cannot as yet be forecast with any degree of certainty. Hardly out of the laboratory, it has yet to find its proper place in the scheme of hard materials where performance and cost must ultimately strike a balance. The cemented carbides have made a name in some two-score wear-resistant uses already, such as textile guides, swaging anvils, collets, sorting machine fingers, press trip dogs, and spinning tools, and Norbide may replace them in certain instances where the added life of a part justifies a higher cost—in every instance an individual problem of production economy.

Certainly the field of parts is big enough to hold both the cemented and this new uncemented non-metallic type of carbide. As fast as there is economic justification for using these products of research, just so fast will they be placed in use; and the performance of the carbides in all three fields noted proves them to be among those products for which justification grows apace.

Norbide, an uncemented carbide, is made from coke and boric acid (*above*), and may be molded into many shapes as shown in the illustration below

OUR POINT OF VIEW

Too Much Scotch?

SCIENCE at last has "diplomatically recognized" the Loch Ness monster. At a recent meeting of the Linnean Society of London this mystery of the Scottish loch was for the first time seriously discussed by scientists assembled, and data obtained by Sir Edward Mountain with the help of 20 watchers armed with field glasses, cameras and telephoto lenses, were presented to the naturalists of Great Britain.

Now that science has given the monster a hearing we may expect—what? A quick simple solution of the puzzle? One might be excused for jumping without thought to such a conclusion. But science is as badly baffled as the remainder of the world. Scientists thus far can only name with certainty some of the animals that it is not. For example, the paleontologist William K. Gregory of the American Museum of Natural History, who visited the scene of the animal's antics but did not see any of them, is able to dismiss from serious consideration numerous descriptions which combine the characteristics of a mammal's face and the hind feet of a reptile, and others which, more resourcefully than scientifically, combine in a single animal the features of several different reptiles, several different mammals and a fish.

The 20 watchers organized by Sir Edward Mountain actually saw the monster 21 times, so it is no mere myth. Photographs of it, taken by them and reduced to definite data (the angle subtended at the known distance) cause its mythological magnitude to dwindle to a mere eight feet—a sad come-down from the multiple-humped "sea serpent" of the newspaper reports. That it is a seal or an otter was the suggestion of some of the Linnean scientists who discussed the findings in London; also that it is not a killer whale, as has been supposed.

But it remained for Sir Arthur Smith Woodward, the anatomist, to deprive the monster of the most romantic touch of all. He points out that it cannot be a dinosaur, because if that were the case dinosaur fossils representing its ancestors during the 54,000,000 years since the end of the Age of Reptiles when dinosaurs are believed to have become extinct, would have been found in rocks of the ages since then. Even the case-hardened scientist will regret the exclusion of the dinosaur interpretation, for it would be such fun—a real thrill—to discover a real live dinosaur on earth today.

Anyway, why should a dinosaur choose, of all places, chill, raw Scotland as its domicile? But the verdict "not proved," rendered by the English naturalists, was a Scottish verdict, at any rate.

Speed and Mental Peace

IT has become a trite saying that we are living in an age of speed. Within the short space of a generation, the speed of transportation has increased many fold; the tempo of life in general has kept pace. Science has contributed largely to the development of speed but has it also contributed in like measure to mental peace and happiness?

No less a well-known personage than Owen D. Young recently sounded a pertinent note regarding the effect of speed on our daily lives when he warned American youth to slow down the tempo and to live a more sane, evenly balanced life. In the United States, the one predominant thought of youth—and all too frequently of middle age and old age as well—is "Where shall we go from here; what shall we do next?" This outlook, coupled with the readily available motor car and other forms of transportation, makes of life in general a mad merry-go-round of speed.

What effect can all this have on our mental peace and happiness? Surely happiness does not consist merely of excitement, of rushing hither and yon and eventually getting nowhere. Speed suffices for the moment; it furnishes an artificial stimulation which for the time being passes for a more or less satisfactory form of mental happiness. But what of the end product? What of the intellectual satisfaction that must be obtained if each individual's life is to be considered complete? Speed in its place has advantages. In transportation for business purposes it has added immeasurably to our creature comforts. Used sanely it is one of the most desirable developments which have been made possible by applied science. Used insanely, as it too often is, it is frequently a source of dissatisfaction, of mental unrest.

Mr. Young spoke wisely, sanely, instructively, when he ventured the opinion that we should slow down the pace, live more fully, enjoy the fruits of life which can be enjoyed only when savored slowly and to the full. Skimming rapidly along through this human existence, touching the high spots, missing the full flavor of life in all its ramifications is the shallow, superficial way of living. Slowing down, taking things easy, living life in what might be called the old-fashioned way, will enable people to enjoy the full benefits of this age of speed without burning themselves up prematurely and living in a state of continual unrest.

Scientific Architecture

SCIENCE today touches and influences practically every material object in our daily lives. It would not seem, however, that architecture, one of the oldest human arts, would show that influence very strongly. Building design and construction, if we disregard ornamentation, was essentially the same a very few years ago as it was when the ancient inhabitants of Ur discovered the principle of the arch and the dome. Recent advances, however, have made necessary studies that will without doubt radically change our building forms and structure.

It is not so long ago that metallurgical progress, making possible the fabrication of steel frames, and the invention of the elevator, started the trend toward skyscrapers. Scientific research in brick and other building materials has also contributed to the taller buildings. Welding may enable us to go a step further and eliminate riveting of structures. Other more important conditions will change both business structures and the homes of the future.

Much experiment has been carried on in the development of monolithic concrete houses. Steel houses and houses employing glass building blocks have also been widely discussed and both show great possibilities. Perhaps one of the greatest influences now pleading for close study as to its relation to building design is air conditioning. Use of this very new invention will make necessary much closer attention to questions of insulation against heat transfer than heretofore.

National interest is rapidly turning toward the question of our housing needs as discussed on page 58 of this issue. In our minds, it is a question now of whether the very large number of residences which must be built in the next few years will be built according to the findings of science or in the traditional haphazard fashion. Much can be done, at little increase in cost, in building for human comfort and health, and these are both vital.

THE MINIATURE CAMERA

The Advanced Amateur's Jack-of-all-Trades . . . High-Speed Lenses . . . Fast Films . . . "Gadgets" . . . Wide Range of Choice . . . Great Enlargement Possible

By JACOB DESCHIN

Miniature cameras are made in a wide variety of shapes and prices to fit all requirements

EQUIPPED to photograph anything from a bee to a ball game and capable of "shooting" from ambush, around corners and from myriad angles in myriad situations, the miniature camera is today luring new converts to photography and creating a veritable golden age of picture-making in this country.

A development of but a few years, the vogue of the small camera that can be slipped into the pocket or hung suspended from the neck while one strolls along, has grown so rapidly that the would-be amateur photographer in search of a suitable instrument is bewildered at the very start by the enormous variety of cameras, lenses, attachments, and what not, which vie for his favor.

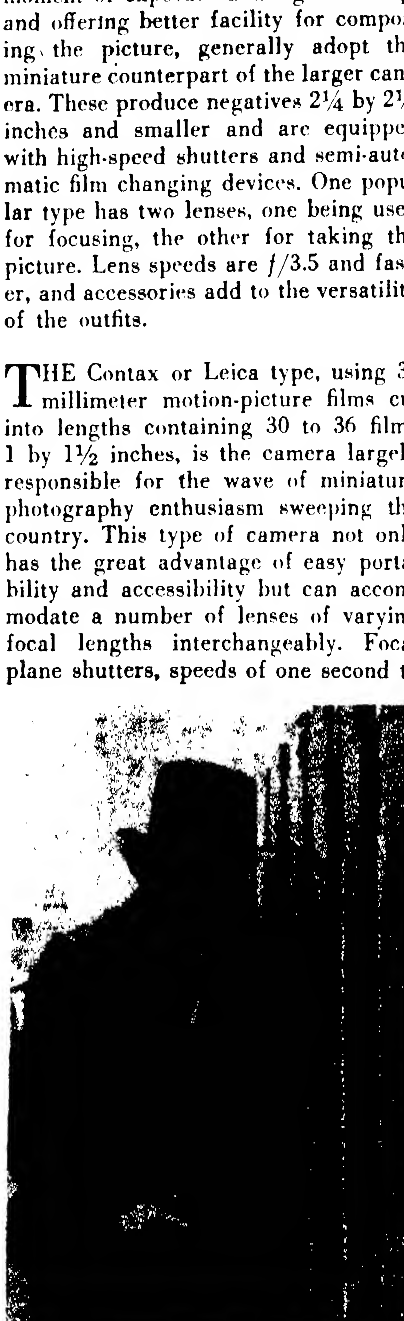
To decide the approximate price one is willing to pay for a miniature camera is to limit the field at once and simplify matters to some extent. Other considerations are the type of work one wants to do; the preferred size of negative, although since the term miniature officially applies to negatives $2\frac{1}{4}$ by $3\frac{1}{4}$ inches and smaller, this should not offer much difficulty; the preference one may have for the reflecting type of camera or the "eye-level" type; the accessories available for the camera, and other points which gradually simmer the choice down to perhaps two or three similar cameras in the same price range, all equally good but one, eventually, standing above the rest because of some point which may seem to give it superiority in the eyes of the purchaser.

In the classification of miniature cameras will be found the small folding type using vest-pocket roll film and equipped with an $f/4.5$ lens and a direct vision finder and ranging in price up to about 35 dollars. The lenses supplied with the less expensive cameras are of course not as highly corrected as those of the expensive types, neither do the shutters give as complete a range of speeds, yet they permit making fair enlargements. The scope of these outfits is naturally small, but for the usual run of amateur pictures they will be found fairly suitable.

BETTER grades of cameras in this same class are distinguished from their less costly brethren by superior lens equipment. Better corrected and speedier, these lenses range from $f/3.5$ to as fast as $f/2$, making them useful under nearly all lighting conditions. These cameras are equipped with Compur shutters, and speeds range from as slow as one second to as fast as 1/300th of a second. View finders for these cameras are accurate, and in the Super Ikomat a built-in range finder permits automatic focusing. Provision is also made for the use of either 8 or 16 negatives on the same roll film. As in the cheaper models, only one speed or focal length lens may be used, though auxiliary lenses, called proxars, are available for shortening the focal length to a limited extent. Many a miniature camera worker has done exceptionally good work with this type of camera and would have none other. They are precision built and made of the best materials and with great attention to all details.

Those accustomed to the use of the reflex type of camera such as the Graflex, with the ground-glass focusing device showing the subject up to the moment of exposure and right side up, and offering better facility for composing the picture, generally adopt the miniature counterpart of the larger camera. These produce negatives $2\frac{1}{4}$ by $2\frac{1}{2}$ inches and smaller and are equipped with high-speed shutters and semi-automatic film changing devices. One popular type has two lenses, one being used for focusing, the other for taking the picture. Lens speeds are $f/3.5$ and faster, and accessories add to the versatility of the outfits.

THE Contax or Leica type, using 35 millimeter motion-picture films cut into lengths containing 30 to 36 films 1 by $1\frac{1}{2}$ inches, is the camera largely responsible for the wave of miniature photography enthusiasm sweeping the country. This type of camera not only has the great advantage of easy portability and accessibility but can accommodate a number of lenses of varying focal lengths interchangeably. Focal plane shutters, speeds of one second to



A fine character study, made unobserved by the subject; the camera equipped with an angle view finder

1/1000th of a second, film-winding device which makes double exposures impossible, extreme accuracy in focusing, automatic counting knob which indicates the number of exposures made, and other features make this type of camera one of the most perfect miniature photographic outfits on the market today. Enlargements, governed by the character of the film emulsion used, the slower or average speed films giving better results, can be made up to 35 to 40 times the original.

HAVING purchased his camera, the amateur has his hands full for the time being with the job of mastering its operation. "Fine grain" film specially manufactured for miniature cameras is available for almost all purposes. The camera fan can buy either orthochromatic film, which is sensitive to all colors except red, or he may wish to use the fastest film material available and take immediately to the super-sensitive panchromatic film, which is not only sensitive to all colors but works under the worst lighting conditions. Experts generally advise the use of average speed orthochromatic or panchromatic film because of the better grain and contrast results obtainable. There is a wide variety of these films and the problem of determining which particular brand to use is not a simple one to solve, but it is advisable to make a definite choice as soon as possible and to stick to the one type of film all the time. Only in this way will the photographer eventually know his camera's limitations and possibilities.

The person who buys the low priced miniature camera is generally content with what it will do by itself without any thought of adding accessories beyond, perhaps, the purchase of a filter to get cloud effects. For those in the upper brackets, and these include the type of devotees who take their hobby seriously and buy the best outfit they can afford, even if it means skimping on lunches for months to come and doing without other things, there exists a fascinating world of lenses and accessories to the possessor of which almost nothing is impossible.

Short time exposure with a miniature camera. Light furnished by a candle 2½ feet from subject

Speed lenses of phenomenal capacity, used with highly sensitive films, make possible the taking of fast snapshots at night, indoors and out, and under difficult lighting conditions, "shooting" fast-moving sporting events, and similar subjects. So-called telephoto lenses permit the photographer to "bring" distant objects closer to his camera and in enlarged form, thus providing the equivalent of a closer vantage point. This facility of filling the entire area of the film with the object photographed, excluding everything else, is of the greatest importance in miniature photography, inasmuch as the small size of the negative material makes it imperative, if clear, sharp enlargements of 8 by 10 and 11 by 14 inches are to be had, that all or nearly all, of the film, be used as the basis for enlarging.

This barber-shop scene is a snapshot taken at night with only the illumination from the lights in the shop. Angle view finder was used

Caught in action. A 1/500th second exposure "stopped" the horseshoe as it was making a "ringer"

After he has gotten the "hang of the thing" and achieved some success with his hobby, the camera fan begins to be attracted to the innumerable "gadgets" being offered by the various manufacturers. There is the angle view finder, by means of which the photographer may take pictures unsuspected by the subject; the reflex attachment for converting the Leica or Contax type camera into a reflex camera, thus combining two types of camera in one; the panorama tripod head which permits the miniature camera to do the work of a regular panorama camera; apparatus for converting the cameras into a stereoscopic camera; attachments for photomicrography; flash lamps accommodating flash bulbs which may be attached to the camera and made to operate simultaneously with the release of the shutter so that flash and shutter act together; single-exposure attachment with focusing device for close-ups of 10 inches; copying attachments, and many other devices allowing the owner of the miniature camera unlimited scope in his camera adventures, including even color photography.

WITH miniature cameras and accessories at their present perfection it seems hard to believe that anything better could possibly be produced, but small hints that come seeping through to the outside world now and then from the laboratories of photographic engineers and chemists give rise to much speculation on the possibility of unrevealed wonders being hatched behind tightly closed doors.

●

A comprehensive listing of representative miniature cameras available in the United States has been prepared, giving lens speed, focal length of lens, type of shutter, range of shutter speeds, size of film used, and list price. This list will be mailed free to interested readers upon request. Enclose a stamp to cover mailing.—The Editor.

THE MOST INTERESTING

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

IF we look straight up into the sky on a clear February evening the brightest star above us will be Capella. It is at one corner of a very irregular but rather conspicuous pentagon of stars by which we may recognize the constellation Auriga (Figure 1).

Four of the five stars in this figure are objects of unusual interest. Capella (Alpha) itself was the first double star

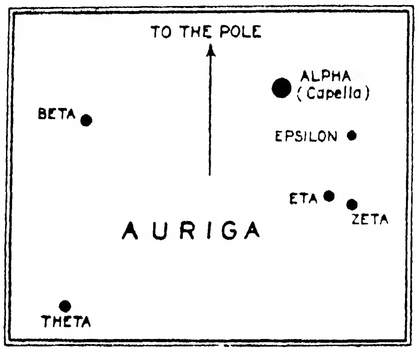


Figure 1: **Showing Zeta in Auriga**

to be separated by the interferometer, its two brilliant components revolving in a nearly circular orbit in a period of 104 days, just too close to be separated by direct vision with the greatest telescope. Beta Auriga, to the west, was one of the earliest stars whose duplicity was discovered with the spectroscope. Precise observations have revealed shallow eclipses at intervals of two days, which give us accurate knowledge of the real sizes of the stars. Passing across Capella, and to the next corner but one, beyond, we come to a pair of stars nearly equal in brightness and close enough to count together as the corner of the pentagon at first glance. The eastern of these two, Zeta Aurigae, has been shown by recent work to be perhaps the most interesting star in all the heavens.

Nearly 40 years ago Miss Maury, examining the Harvard photographs of spectra, noticed that this star was peculiar. In the green and blue it resembled an ordinary star like Aldebaran, but in the violet and ultra-violet, where an ordinary red star has but little light, the spectrum was still strong and showed the wide hydrogen lines characteristic of hot stars. The explanation was obvious. This star must be a close double, with components of very different temperatures and colors. Except in the violet the light of the red star predominates over that of the other.

Further evidence that the star was double came when Campbell at the Lick Observatory found changes in its velocity but it was not till 1924 that Harper of the Dominion Observatory at Victoria worked out the orbit. The red star, of spectral class K5, revolves with a period of 972.4 days, in an eccentric orbit a little bigger than that of Mars, about the center of gravity of the system. On the other side of the center, swinging opposite to keep the balance, must be the fainter white star. The Canadian's plates did not go far enough into the ultraviolet to show the lines of this component, but they have been detected recently by the French observer Tranblot, who finds that this star is about twice as far from the center as the other and must hence be only half as massive.

THOUGH the few-lined spectrum of the white star cannot be seen separately in the blue, it is strong enough to fill up the dark lines of the other spectrum and give it a "washed out" appearance. Harper noticed, however, that on one of his plates, taken on January 18, 1924, there was no such effect. Calculating the positions of the stars, he found that, at the time, the red star must have been almost in front of the white one, close to the place where an eclipse would happen if the orbit was turned nearly enough edgewise toward us.

For almost eight years—three revolutions of the pair—little more attention was paid to the star. But in 1932 the German observers Guthnick and Schneller found that the same change recurred in the spectrum, and that simultaneously the star's brightness dropped by nearly half a magnitude. An eclipse undoubtedly occurred, and a remarkably long one, for the light stayed down and the spectrum remained unblended for three weeks.

The next eclipse could now be predicted with some accuracy as due to begin in the latter part of August, 1934, and run till late in September. Many observers in different countries, with the best of spectroscopic and photometric apparatus, were on the watch for it. Their results are only beginning to be published but they tell a remarkable tale.

The last eclipse began on August 24th and ended on October 1st. During the 38-day interval only the spectrum of the red star was visible and the total light had diminished by a quarter of a magnitude by visual measures, and $0^{m}.6$ photographically. The day before the beginning, and the day after the close, the star was at full light and the spectra completely blended. It therefore took less than 24 hours for the white star to hide itself behind the edge of its huge red neighbor. Just how much less, the reports so far published do not settle, but it is clear that the larger star is at least 40 times the diameter of the other—perhaps 60 or even 80. Compared with its primary it is a mere speck, smaller in proportion than Jupiter's four prominent satellites or than Uranus or Neptune compared with the sun.

IT is no feeble satellite, though: it shines intensely. In visible light—that is, in the yellow and green—the larger star is about four times as bright as the other; in the violet only one and a half times; while in the ultra-violet the small star is actually the brighter. With 1/60 the diameter it must give out 900 times as much yellow light per square mile as its companion, and 4000 times as much ultra-violet. At first sight this difference seems incredibly great, but it is no more than might have been expected. The spectrum of the large star K6 (according to Mount Wilson plates) indicates a surface temperature of 3200

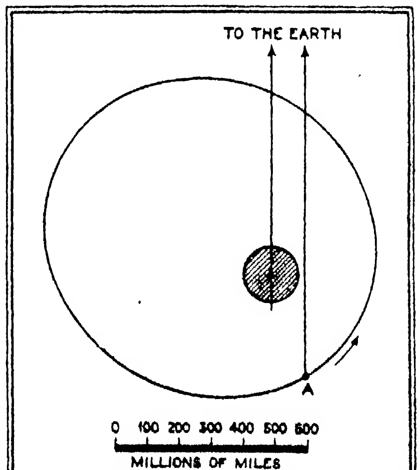


Figure 2: **System of Zeta Aurigae**

STAR IN THE SKY

Zeta Aurigae, a Close Double Star . . . Red and White . . . Giant and Dwarf . . . Now Visible . . . A Five Week Eclipse . . . Remarkable Tale

degrees or a little lower: the companion shows helium lines and is of a fairly early division of class B, which corresponds to a temperature of at least 15,000 degrees.

Surfaces of standard radiating power at these temperatures should differ in their light emission by a factor of about 600 in the yellow-green and 6000 in the ultra-violet—which agrees as well as could be expected with the rough estimates which can so far be derived from the published observations. With a red star as cool as Antares, and a white one as hot as its neighbor in Scorpio, the difference per square mile would be even greater. Strange as the results are, then, they make sense. The only trouble is how two such very different stars come to be such close companions—probably of a common origin. In our present absolute ignorance of the reason why some stars are large and cool and others small and hot we can attempt no answer.

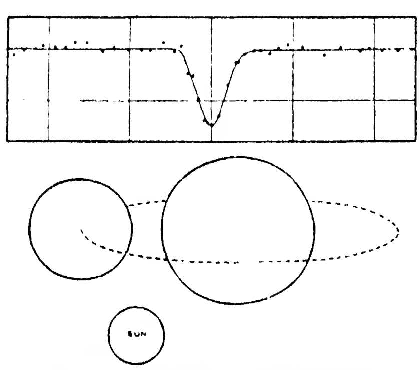
WITH the aid of Tranblot's measures we may now calculate the actual size of the system—assuming for the moment that the small star passes squarely behind the middle of the big one.

The average separation of the two stars is 530 million miles—ranging from 310 million 70 days after the middle of the eclipse to 750 million a year and four months later. The diameter of the large star is 175 million miles, or about 200 times that of the sun; of the small star, three or at most four million miles. The former is a typical "super-giant," like Betelgeuse or Antares, though not quite so big, while a number of stars similar to the latter are already known among eclipsing variables.

Figure 2 shows the stars and their relative orbits—except that it is hardly practicable to make a dot small enough for the little fellow.

Greatly as the stars differ in other respects they are still more unlike in density. The small star is eight times as massive as the sun which, with our rough estimates, makes its density one third to one eighth of the sun's—fairly normal for stars of its spectral class. But the large star has nearly 8,000,000 times the sun's bulk and only 16 times its mass, so that its mean density is only 1/500,000 that of the sun or about 1/500 that of air under familiar conditions.

Here again is an apparent paradox. How can so excessively thin a mass of gas be opaque enough to eclipse a brilliant star? In the first place it is very wide. If it was all of uniform density the 175,000,000 miles of gas along a diameter would be equivalent to 350 miles of ordinary air. The light of the setting sun has traversed much less than this, and yet it is cut down to far less than one percent of its original amount. But, if this were all, the outer and thinner parts of the star would really be transparent. We know, however, both from theory and from observation of the sun, that a highly heated gas ionized and full of free electrons is naturally hazy and, even at a very low density, would be opaque in a thickness of a few thousand miles at the most.



Typical eclipsing variables. *Above:* W. Volantis, showing drop of about one magnitude during the eclipse. *Below:* The ellipsoidal stars and orbit of V. Leporis, as determined by Martha B. Shapley at Harvard College Observatory. The sun is shown for size comparison

So there is no real difficulty. We might expect, however, that the transition between dense haze, opaque to light from behind, and empty space above would be more gradual at the star's surface than on the far denser sun, and this conclusion is confirmed by a simple calculation which shows that the force of gravity on the star's surface is but 1/2500 of that on the sun. Direct evidence of such an atmosphere has been obtained at the present eclipse and in the preceding one of 1932. At that time Guthnick, photographing the spectrum just after the companion had come out of eclipse (as illustrated at *A* in Figure 2), found that the *K* line of calcium and some other metallic lines were stronger and sharper than when the companion was well at one side of the primary. These lines did not appear when it was obscured, and hence do not come from the principal star. They must be absorbed from the light of the companion when it merely grazes the surface of the other; that is, the great giant star has a thin transparent atmosphere, a gaseous envelope, rising many millions of miles above its surface. We know that the sun has a similar but shallower envelope, the chromosphere, thousands of miles deep, all over its surface and rising ten times as far here and there in the prominences. With the smaller force of gravity on the star a chromosphere millions of miles deep would not seem absurd. When the next eclipse happens in April and May 1937 we may be sure that these unique and interesting observations will be repeated.

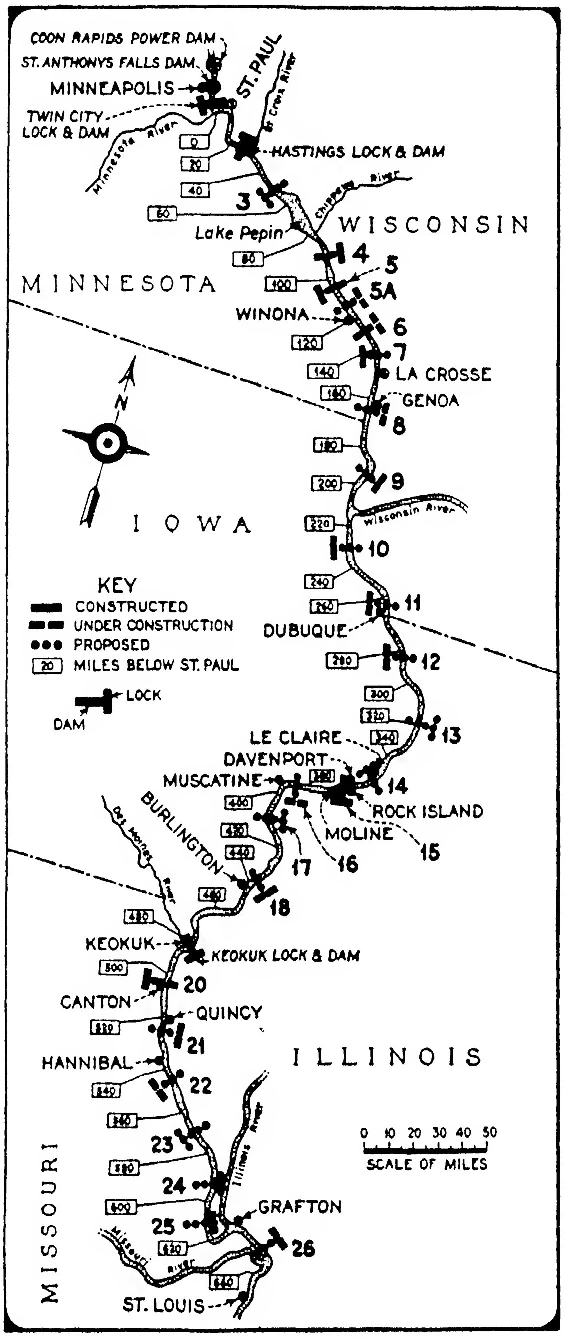
THE actual luminosity of Zeta Aurigae must be very high. The giant red component, judging by its temperature, is likely to be about 1/40 as bright visually as the sun for equal areas—which makes its estimated light 1000 times the sun's. The white star may be 15 or 20 times as bright per square inch as the sun and give out 200 or 300 times as much light. The combined light therefore may be estimated as 1200 times the sun's—pretty bright but by no means extraordinary. To the eye this appears as a star of magnitude 3.94. The corresponding distance is 750 light years—much farther than the majority of naked eye stars. When the components are farthest apart at right angles to our line of sight, as will happen in 1936, their angular separation will, on this reckoning, be 0″.033—too close to separate with any telescope, but within the power of the interferometer. The inequality of visual brightness, however, will probably make it impracticable to "see" the star double, even with this aid.

Before we leave Auriga we may recall that Epsilon Aurigae, between Zeta and Capella, also shows apparent eclipses at a still longer interval, 27 years, and of more than a year's duration. The phenomena are more complicated, however, in this case and we shall have to wait a good while before we get another chance to observe them.—*Princeton University Observatory, December 14, 1934.*

CANALIZATION OF THI

VAST engineering undertakings, because of their number, have become somewhat commonplace of late in this country. Magnificent dimensions stimulate the popular imagination for a while and then cease to interest. But among this procession of major construction projects there is one of which the public generally knows but little; yet it is likely to be of outstanding and enduring benefit to the nation as a whole. This is the really monumental and truly momentous work now in hand for the improvement of the upper Mississippi River.

The upper Mississippi embraces so much of that stream as lies northward of the point where the Missouri meets the "Father of Waters," a few miles above St. Louis. Between the city of Minneapolis and the Missouri, the upper Mississippi is in process of being turned into a great 650-mile canal, which, even at low water, will have a channel that nowhere will be less than nine feet in depth. No matter what may be the volume of the water flowing seaward at any season, a score or more of dams will convert that part of the river into a succession of slack-water pools that will facilitate the movement of flotillas of craft capable of transporting, as unit groups, thousands of tons of cargo at freight rates that will make the business worthwhile and be at the same time a boon to the farmer, to the manufacturer, to the miner, and to the ultimate consumer of commodities of innumerable kinds.



Built, building, and proposed dams and locks on upper Mississippi—Minneapolis to St. Louis

THIS subject is of present moment not because of its newness in principle but by reason of the engineering procedure that is now being followed out to achieve an end long desired but heretofore not attained. More than a quarter of a century ago, Congress authorized taking such steps on the upper Mississippi River as might be necessary to provide at low water a channel not less than six feet in depth. After study, the Corps of Engineers of the Army decided that such a channel could be assured by dredging in some sections and by constructing contraction works in other sections—the latter tending to increase the speed of flow and thus automatically prevent the accumulation of silt and the formation of obstructing bars. This program has never been finished; there are today considerable stretches of the river where boats drawing more than four feet cannot navigate during low-water stages. The completion of a nine-foot channel on the upper Mississippi will make possible trunk-line, common-carrier service from Minneapolis to New Orleans. At the present time, up-bound and down-bound freight is usually transhipped at St. Louis; and this entails loss of time and increased costs.

The prolonged periods of exceptionally low water in the upper Mississippi during the last five years have made it plain to the experts that the nine-foot channel sanctioned by Congress in 1927 could not be realized by recourse to dredging and contraction works. Therefore, after a very careful survey, the Army engineers recommended, near the close of 1931, that the only feasible solution of the problem was to canalize the river throughout the section in question by creating 27 pools upstream of that many dams, the dams to have, with two exceptions, locks 110 feet wide and 600 feet long. The purpose of such large locks is to permit a towboat and its group of barges to pass through a lock without altering its formation—that is, without losing time in splitting up. But the upper Mississippi presents physical difficulties to the execution of such a plan.

THE valley through which the river flows is generally broad and flat. When the river is at flood stage, the surface of the water varies in breadth from half a mile to two miles; and along the banks on each side of the stream and just above flood level, are numerous villages and small cities. At the larger river cities, industrial developments lie along the shores just out of the reach of high water. The tracks of some paralleling railroads are similarly but little above flood levels. Moreover, there are rich farmlands lower down on the upper river that are protected from inundation by dikes or levees that actually have their bases always submerged so that seepage on to cultivated areas makes well-nigh continual pumping necessary. The government engineers had, accordingly, to fix upon types of dams that would raise the natural flood level of the river at no point more than 12 inches, lest property damage be prohibitively great. Low dams were therefore adopted—of just

UPPER MISSISSIPPI RIVER

Trunk-line Water Route From "Twin Cities" to New Orleans . . . 27 Dams With Locks Required . . . Cost 124,000,000 Dollars . . . Economic Gains

By S. G. ROBERTS

sufficient height to impound enough water to provide a minimum channel depth of nine feet. The work has been going forward rapidly during parts of the last three years. When finished, the estimated total outlay will be 124,000,000 dollars.

The changes in water level on the upper Mississippi, in the wet season, may be as much as 18 to 21 feet. It is self-evident that such tremendous volumes of flood water should be given the fullest possible avenues of escape lest they back up and overrun wide areas above obstructing dams. All new dams on the upper Mississippi are designed with spillways and spillway gates that will permit the normal regulation of the river for navigational purposes and yet at flood stages will allow nearly unrestricted escape for flood water. Vessels bound upstream or downstream will pass the dams through locks of the most modern design with electrically operated gates.

It is not enough that the dams be equipped with spillway gates to deal with flood waters, but the same gates must work positively when exposed to either fields or floes of ice which, in the upper Mississippi, attain thicknesses of from 12 to 24 inches. The spillway gates are patterned to free themselves from ice in contact with them; will be able to withstand the pressure of large bodies of ice; and when necessary will be able to open promptly and allow the ice to escape instead of forming disastrous jams. Dam No. 15, popularly known as the Rock Island Dam and now in service, typifies what the Corps of Engineers of the Army is doing in canalizing the upper Mississippi. The dam crosses the river between Davenport, Iowa, and Rock Island, Illinois, and has a length of a little more than 1203 feet from one terminal structure to the other. The dam is equipped with 11 great roller gates that are patterned after a type that has been widely adopted in Scandinavian countries where heavy ice on the waterways has to be contended with in the wintertime. The roller gate is peculiarly suited for such service; besides freeing itself from clinging ice, it incidentally breaks the ice so that the blocks can be swept downstream over the spillway.

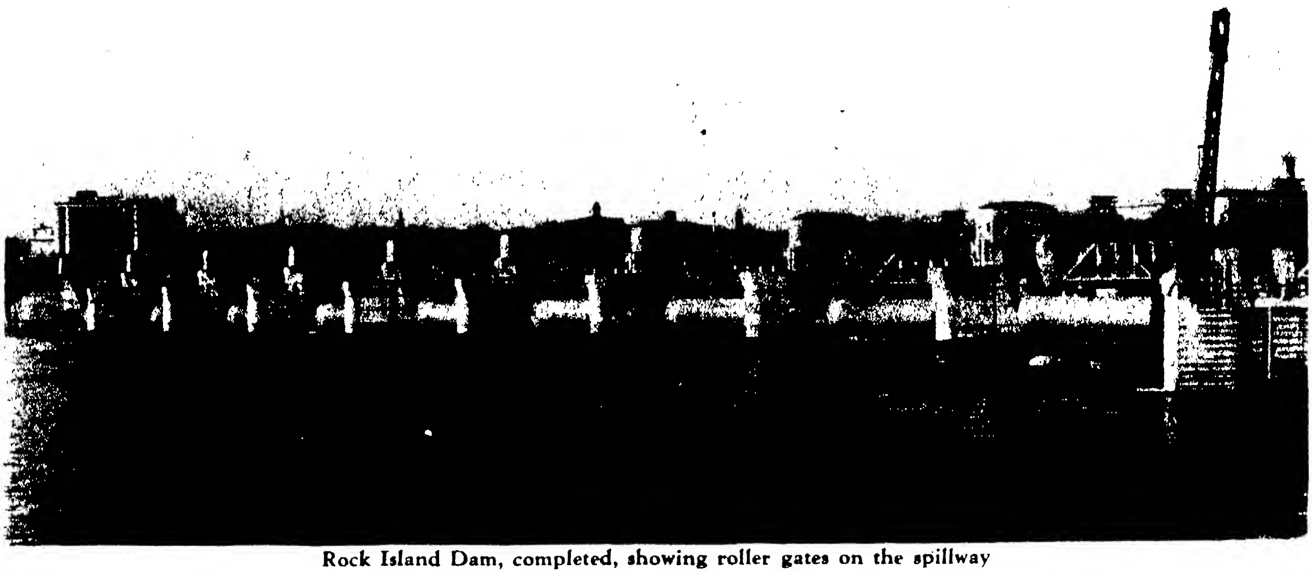
Early construction stages of Lock Number 15 (right) at Rock Island, Illinois. Rock-filled cofferdam may be seen at the left

We cannot, at this time, go into the engineering details of the roller gate other than to say that each one on the Rock Island Dam is a sturdy cylinder of steel having an over-all length of fully 109 feet; most of the gates on that dam have a diameter of 19 feet 4 inches. Each gate has a projecting longitudinal lip that rests against a timber seal on the gate sill when closed. This lip swings clear and rises as the roller gate is partially rotated in moving upward on inclined toothed tracks. A powerful electric motor controls the raising and lowering of a gate; and when at its maximum height, a gate is six feet or more above flood water at the estimated highest level. Electrical heating units at the ends of a roller gate will melt any ice that would otherwise grip the gate and prevent its opening or closing.

The main structures of the Rock Island Dam are anchored on bed rock, but at Dam No. 5, now building about 265 miles farther upstream, the river bed is composed of sand and gravel to a depth of several hundred feet. In that case the reinforced concrete structures rest upon numerous timber and steel piles driven into the underlying formation. Many of the other dams will be underpinned with piling, and only a few of them will be at locations where bed rock can be reached. Because the erection of a dam will block the course of the river, the Government is first constructing a lock or locks at each dam site so that shipping may not be hindered at any stage of the work. At this writing, work is underway on 12 locks; two were recently finished; and four others were built a year ago. Three dams are under construction, and additional activities will soon be started. At the present rate of progress, the magnificent scheme should be an accomplished fact by 1938.

MINNEAPOLIS and St. Paul—familiarly known as the Twin Cities—occupy a strategic position in relation to the contiguous and neighboring states, which to a large extent are essentially agricultural in their productive activities. When not hampered by drought or other unseasonable conditions, Montana, North Dakota, South Dakota, and Minnesota grow annually a billion and more bushels of grain. Save for the outlet at Duluth, this immense region—which has the combined expanse of Germany, France, Italy, and the British Isles—is, for all practical purposes, landlocked.

Through Minneapolis each year is handled between 100,000,000 and 150,000,000 bushels of grain, of which a considerable percentage is bound out of the country. The farmer and the middleman thrive or lose according to the export price, which is determined by the cost of getting the grain to our sea coast. Grain from the northwest traveling by rail to either Duluth or Minneapolis pays the same freight. Should any of that grain, however, after reaching Minneapolis, be forwarded to Duluth to take



Rock Island Dam, completed, showing roller gates on the spillway

advantage of the lower cost transportation on the Great Lakes, then every 100 pounds of grain making the rail journey to the lake port must bear an added charge of five cents. This is a severe handicap to the grain merchants of the Twin Cities which must use Duluth as a port of outlet and cannot seek a competing market.

In the grain trade, a difference of so little as a quarter of a cent a bushel for carriage decides the route by which grain can be shipped profitably to a market abroad. With the Mississippi River available for trunk-line service, the Twin Cities and other communities on the upper Mississippi will be able to ship bulk cargoes through to New Orleans and will thus be placed directly in touch with ocean-going craft without breaking cargo between the shipping point and the Louisiana seaport. On their upward-bound run, the river craft can haul commodities reaching New Orleans from either of our seaboards or arriving there from foreign sources. In short, the canalization of the upper Mississippi, in conjunction with the remainder of that river, will offer a channel for trade that eventually will transform the industrial and the economic life of a great part of the Mississippi Valley that now lags measurably because of the means of transportation today available.

SEVEN years ago the Federal Barge Line, subsidiary of the Inland Waterways Corporation, a government organization, began its pioneer service on the upper Mississippi to demonstrate what would be possible in moving large volumes of water-borne freight with modern equipment run on schedule. Interested people along the water-way raised the funds necessary for the purpose of constructing towboats, barges, and terminals. While the barges were of light draft and could carry only 500 tons each, they demonstrated what could be done with better facilities. It was largely because of the work of the Federal Barge Line that Congress finally authorized the work that is now in hand.

On the nine-foot canalized channel, towboats will be able to maneuver unit flotillas laden with cargoes of from 8000 to 14,000 tons on the down-river trip, and on the upstream run to move groups of barges carrying from 6000 to 8000 tons. These flotillas will be able to make the whole run, if so desired, up or down the river without breaking bulk or changing the flotilla formation the while. There are coal companies and steel companies that even now operate fleets of barges between the Pittsburgh district and the coal mines adjacent to the Ohio River. These concerns transport their commodities to the Twin Cities and to other points on the upper Mississippi. With a nine-foot channelway, this traffic will be much stimulated and everyone concerned will be benefited. But the private flotillas are for the performance of their owners' immediate service; it is essential that common carriers be available to any shipper seeking the advantage of low-cost water transportation in getting his products to profitable markets. With such common carriers, the western half of the Mississippi Valley, instead of being well-nigh exclusively devoted to agriculture, will be transformed into a region engaged in many forms of industry, and enjoy what it cannot boast now—a balanced economic life.

THERE is every reason to believe that the work now under way will give to the Mississippi Valley a trunk-line water route that will mean to the vast region served by it what the Rhine has long been to central Europe. From Minneapolis to the sea, the Mississippi has a length of 1950 miles; and the run from Minneapolis to New Orleans is 1840 miles. From the head of navigation on the Rhine to the sea, the distance is 445 miles. Therefore, the Mississippi offers a water outlet to a far more extensive region than does the Rhine; and the potential wealth of the American domain is infinitely greater and in some respects more varied. The Rhine carries a tremendous tonnage of up-bound and down-bound freight; and upon both banks of that waterway are operated prospering railroads that handle more rapidly goods that can afford to pay for the speedier transportation, while the barges move at a lesser pace and at lower cost goods that do not call for expeditious haulage. Both systems are reaping substantial rewards for their respective services.

Improvements now going forward on the Illinois River, the Ohio River, and the Missouri River will contribute to the importance of the Mississippi River system as a whole. Over some of these associate routes it will become a commonplace to see single towboats of 2000 horsepower propelling flotillas of barges laden with 20,000 tons of coal, ore, crushed rock, grain, and so on. A locomotive of the same horsepower can pull on favorable gradients possibly a maximum of 7000 tons. This, in part, indicates why water transportation offers opportunities to make savings in distribution of products; efficient and more economical distribution is vitally necessary to our complex national life. The canalization of the upper Mississippi River is just one more outstanding effort to this end, and also evidence of our awakened consciousness of what our inland waterways can be made to do.

From the Archeologist's Note Book

Sea fight scenes decorate this vase

Two-storied Pompeiian Houses

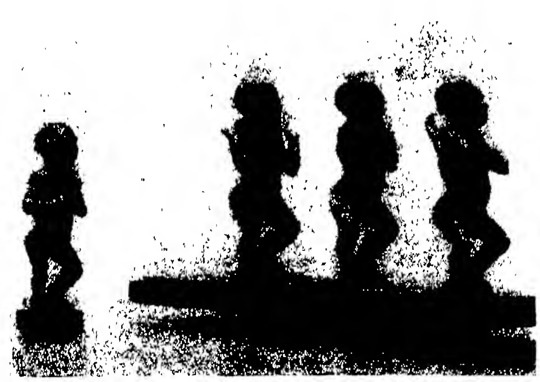
TWO centuries of almost incessant excavation work have helped to make Pompeii one of the most magnificent undertakings by which man has essayed to reconstruct both history and a bygone civilization. Pompeii has been found to have some two-storied houses, and even remains of tenements have been uncovered. Two-storied houses have also been found at Herculaneum, not a great distance away. The new excavations at Pompeii have been much easier to conduct, as mostly only ashes have to be removed for a distance of 19 to 26 feet while the consolidated mud at Herculaneum varies from 39 to 82 feet in depth. Of course, progress is much slower on the latter city but the net results of the two areas are fully justified.

"The Human Adventure"

IT is rarely that a man of the eminence of Dr. James H. Breasted breaks into the movies but archeology has lured him to this medium. An eight reel talking picture has been produced in the centers where the expeditions of the Oriental Institute have been located. Three years were required for the completion of the film, "The Human Adventure," which grew directly out of the researches and explorations of the Oriental Institute and visualizes the rise of man from savagery to civilization. The picture carries the audience by airplane through the lands where civilization first arose—Egypt, Palestine, Syria, Anatolia, Iraq, and Persia. In all, some 14 expeditions are represented. The film ends with beautiful views taken at Persepolis.

An Early Egyptian Toy

THE first elaborate mechanical toy was discovered at Lisht, Egypt, by the Egyptian Expedition of the Metropolitan Museum of Art during the last season. There were four ivory figures on an ivory base. Only one of the figures is in New York; the rest are in Cairo. So far as we know, these are the first representations of central African pygmies. One of the curators of the Museum, succeeding in making paper models of the originals, rigged strings to the spools in the base and made the figures turn in one direction and then in the other and finally make a full pirouette. At first sight the originals seem to have been of Chinese origin, but they were found in undisturbed Egyptian clays. Mechanical toys have been found before in Egypt but always crudely made.



Ivory dwarfs in a toy, found in Egypt

A Colossal Funerary Vase

AN early Athenian grave monument of considerable interest, particularly by reason of its size, has recently been acquired by the Metropolitan Museum of Art. It dates from the 9th to the 18th Century, B.C. Its height is 39 inches and its diameter at the lip is 37 inches. This is a monument from the "dark ages" of Greece, a period of unrest and colonization, perhaps synchronous with the time when Homer wrote.

Pompeii's Terraced Houses

IF the catastrophe of Vesuvius had taken place 50 years later, Pompeii would probably have become a factory town. As it happens, new excavations show a great many varieties of dwellings which indicate residences of people of comfortable means. Several houses have been discovered which are elevated on beautiful terraces as well as set back from the street by gardens.

Lion attacking bull: from Persepolis, Persia

A set-back Pompeiian home resting on terraces

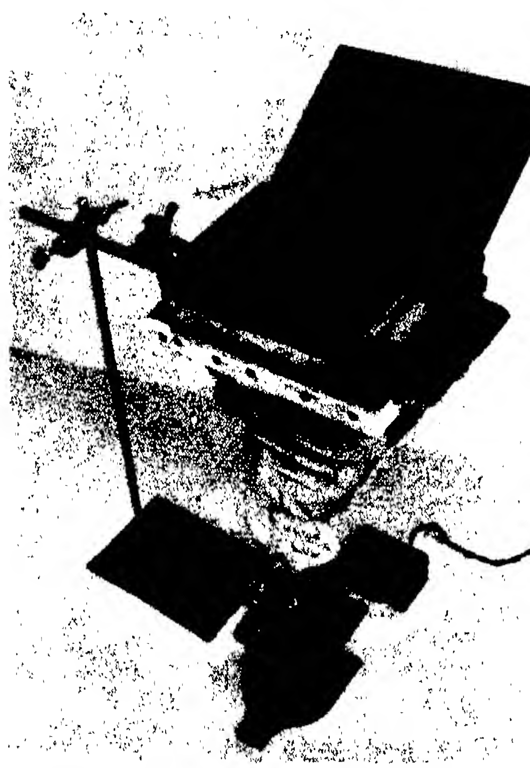
Making Your Own PHOTOMICROGRAPHIC CAMERA

By JOHN KENNEDY

THE optics of a photomicrographic camera are extremely simple—such a camera does not even require a lens, since the ocular lens of the microscope functions in this capacity. To prove this for yourself, observe some specimen under the microscope in the usual manner; then, with the object in focus, darken the room and hold a piece of white paper horizontally eight or ten inches above the eyepiece of the microscope. An exact (real) image of the specimen will fall on the paper. If this paper were photo-sensitive a photomicrographic impression would have resulted. You will notice, on raising and lowering the paper, that the image becomes enlarged and diminished, respectively, in size. By varying the projection distance in this way any desired size of picture can be obtained.

The author has developed a simple, very efficient, and durable photomicrographic camera which can easily be built by anyone, with the total expenditure involved for materials not exceeding one dollar. The camera is of the ground glass focusing type and uses a film pack in an adapter. It consists essentially of an adjustable bellows, with a frame of sufficient rigidity to support the adapter. The latter is a light-proof box which holds the film pack, and is provided with a sliding metal shutter. The adapter is easily lifted off the frame and a ground glass plate substituted. The image of the object on the microscope stage is projected on this plate and the microscope adjusted till this image is focused sharply on the plate. This plate occupies exactly the same position on the frame as the film itself, hence an image in focus on the ground glass plate will obviously be in focus on the photographic film also, when the plate is replaced by the adapter.

THE frame should be made of light but strong wood (white pine is good), one inch square. The size of frame is determined by the size of film pack to be used. However, it is a simple matter to make the frame large enough to accommodate the largest size of film pack manufactured, namely five by seven inches, in the event that on some special occasion it might be necessary to work with such a size. A frame whose inner dimensions are five by seven inches will be ample for this purpose. The long and short side pieces should therefore by nine inches and seven inches in length, respectively. The ends should be given a corner half lap joint (Figure 1) and glued together. Before the glue has dried, the ends should be further secured by fastening them with metal corner supports or braces on the under side (Figure 2).



The completed home-made unit, ready for use

To this frame is attached the extension bellows. The bellows is made up of a chamois skin which is attached at intervals to rectangular wire frames of gradually decreasing size. The chamois may be attached to the frame with carpet tacks or preferably thumb tacks. The chamois skin is merely sewed around the wire frames with heavy thread (Figure 3). The wire frames are made from wire of about ⅛ inch diameter and bent into the shape desired, the ends being fastened by winding or braiding one over the other, as an electrician would splice house wire. Several inches of chamois should extend below the smallest wire ring. A strong elastic band is slipped over the outside of this portion so that it can be snugly fitted over the eyepiece of the microscope.

The bellows itself is now complete and is best supported by an ordinary laboratory ring stand with jaw clamp. It is necessary now to provide the bellows with an adapter for holding the photographic film. An adapter of the type to be described is built to accommodate but a single size of film pack. Hence, for every size of film to be used there must be a corresponding adapter. Since the most popular size of film pack used in photomicrography is 3¼ by 4¼ inches, dimensions for making an adapter for this size alone will be given. A shallow cigar box fills this rôle very satisfactorily. The box should be ½ inch shorter in length than the longer side of the bellows frame. This allows just room enough for the jaws of the ring stand clamp to grasp the frame.

THE optical center of light passing from the eyepiece of the microscope theoretically should pass through the center of the boot, or narrow end of the bellows up through the center of the frame. With this in mind, set up the bellows over the microscope with the use of the ring stand and clamp, and adjust the apparatus until the cone of light passes through the center of the bellows. If a piece of thin tracing paper be placed on top of the frame it will greatly facilitate in making this adjustment, since the image of the circular field will fall on the paper and will show clearly when it lies in the center of the frame. Now place the adapter box in its proper position on the frame, making allowance for necessary room for the jaw clamp on the left, and find where this optical center intersects the bottom of the box. With this point as a center draw a rectangle 3 by 4 inches on the bottom of the box. Then, with a

Simple, Efficient, Durable . . . Materials Cost One Dollar . . . Wooden Frame . . . Chamois Skin Bellows . . . A Few Other Gadgets and an Evening or Two of Time

sharp knife, cut this rectangle out, leaving the box with a rectangular opening.

Place a $3\frac{1}{4}$ by $4\frac{1}{4}$-inch film pack inside the box over the opening, in such a way that only the metal frame of the pack rests on the bottom of the box, thus allowing the entire surface of the safety cover paper and subsequent films to be exposed to light passing through the opening from below. With a pencil, trace the outline of the film pack as it rests now on the box bottom. Cut several strips of felt or similar material $\frac{1}{2}$ inch in width and of the necessary length,

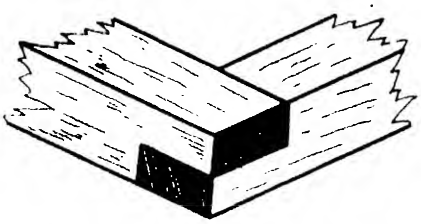


Figure 1: The wooden framework

and glue them on to the box around the trace lines (Figure 4). This will help to keep the film in the desired position, and will also keep extraneous light from the films. To keep the film pack rigidly in place when films are being changed, it is advisable to glue a foreshortened mouse trap to the bottom of the box so that the jaw of the trap presses down firmly on the top of the film pack (Figure 5).

The adapter must have a shutter. This is made very easily from a smooth sheet of tin or similar metal. The shutter slide should be slightly smaller in size than the bottom of the adapter box, except that on the right side a small portion should project for use as a tab for grasping, when the shutter slide is to be pulled out. The slide supports or guides are more difficult to contrive. Two pieces of tin, about $2\frac{1}{2}$ to 3

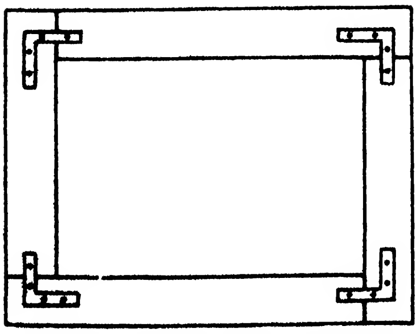


Figure 2: Angle plates at corners

inches wide, and of the same length as the box, are required. These are bent crosswise into a V shape of about 90 degrees. They are then lined on the inside with felt or very heavy cloth, using glue as a binder, and then glued to the side of the box (Figure 6). In this final gluing operation the slider should be in position and moved back and forth from time to time in order to ascertain whether or not it is free to move. One should strive to fasten the guides in such a way as to hold the slider snugly in place against the under side of the box without impairing its requisite ease of motion. It is not at all

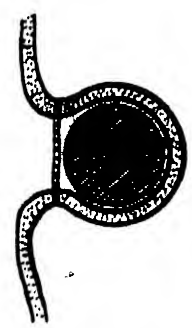


Figure 3: Cross-section of bellows

difficult to do this in a neat manner.

The adapter is now complete, and should be coated on the inside (at least)

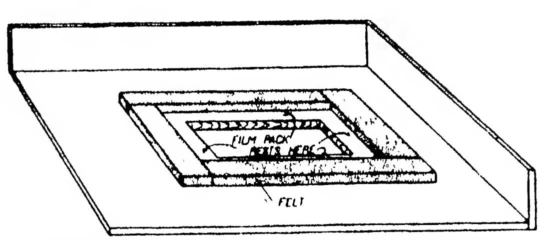


Figure 4: Showing the film pack compartment

with a coat of flat black paint. [One kind is known as "coach black".—*Ed.*] The slider should also be painted black. The bellows should be blackened around the frame, while the chamois portion may be dyed black or painted black on the inside with India ink. Place the adapter back on the bellows frame in its proper position. To establish this position and to obviate any difficulties which might arise later in finding this exact position, two corner guides may be attached to the frame at one end, as shown.

It can be seen, now, on critical examination, that there are two openings through which light might enter: namely, at the two ends of the bellows frame, between the slider plate and the frame itself, because of the slider guides. To close these openings it is necessary only to glue to the frame at these places one or two thicknesses of chamois or cloth strips, depending on the magnitude of the openings.

The next piece of necessary equipment is the ground glass plate. This plate should be of the same size as the bottom of the adapter and should fit in precisely the same position on the frame

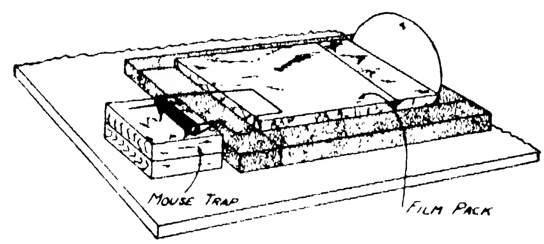


Figure 5: The film pack held by a mouse trap

as that occupied by the adapter. A piece of glass of the ordinary window pane variety is cut to the proper size and one side is ground with a fine grade of automobile valve grinding compound. This may best be accomplished by taking a little of the compound on a flat hard surface, such as a metal spatula or a

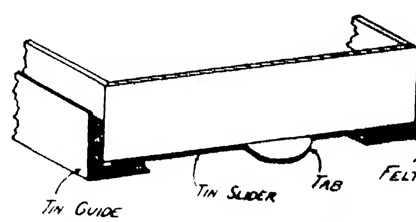


Figure 6: End view of the adapter

broad flexible knife, and then rubbing it into the surface of the glass, using a circular motion. One should strive to obtain a uniform frosted appearance over the entire surface of the glass. The plate should now be finished off with a border of adhesive tape (see Figure 7), which will prevent the edges of the glass from

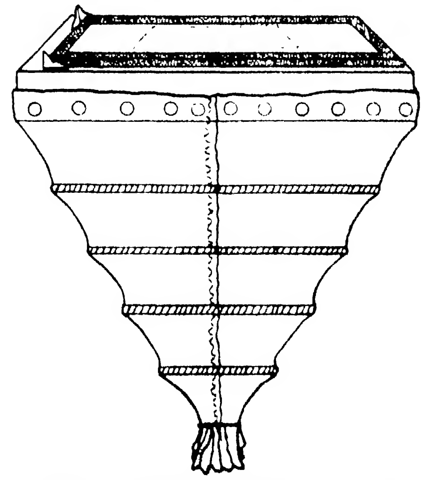


Figure 7: Bellows with ground glass

chipping when the plate is moved about, and will make the plate easier to handle. Theoretically the plate should lie in the same plane as the photographic film. To satisfy this condition small lifts may be glued to the corners of the plate. Small corks are ideal for this purpose; they should be cut to such a size that they raise the plate up evenly to the desired height. However if the plate is laid

on the frame without any lifts it will cause no appreciable error between the size of image observed on the ground glass and that photographed.

Place the ground glass plate on the frame, ground side up. Then, after removing the slider from the adapter, place the latter on top of the plate. Trace the outline of the opening in the bottom of the adapter on the ground glass plate with a lead pencil. The resulting trace lines facilitate greatly in focusing and centering the image on the glass, since they show just what area will be included on the film.

The camera now lacks but one minor accessory, an eye shade of some kind to facilitate viewing images on the ground glass plate. A shade of this kind need not be elaborate and may be made from heavy cardboard. An empty cylindrical container (similar to those in which salt is packed) from which the top and bottom have been removed is satisfactory. It may be necessary to glue a strip of chamois or other fabric around the bottom rim in order to assure a snug fit between carton and glass. The shade is laid on top of the ground glass plate, with the result that the image stands out more sharply in relief against the dark background.

WHEN the camera is to be used, the bottom boot of the bellows is fitted tightly over the microscope eyepiece, using an elastic band around the outside of the boot. The bellows is supported rigidly by the ring stand clamp, care being taken to adjust the bellows so that the beam of light from the microscope passes up through the center of the bellows. Now place the ground glass plate in its proper position on the frame, ground side downward. Then lay the eye shade on top of the plate and adjust the microscope until the image falls sharply on the plate. Then raise or lower the bellows on the ring stand until the image assumes the size desired. For photomicrographic work a 300-watt or a carbon arc lamp is recommended, although lamps of weaker intensity can be made to work quite satisfactorily as a source of illumination.

With everything in focus, replace the glass plate with the adapter, which should contain a film pack ready for exposure (directions for using film pack accompany each pack). Place a piece of black paper between the source of light and the substage mirror. Now open the adapter sliding shutter full length, withdraw the piece of black paper from the front of the mirror and time the exposure. This will be discussed below.

Photomicrographs made by the author with the unit described in this article. *Left:* Chalk, magnified 150 ×. *Center:* Crystal growth of anthranilic acid, × 175. *Right:* Sublimed crystals and stalactite growths of pure hexachloroethane, × 150

At the end of the exposure replace the piece of black paper and immediately push back the slider shutter into its normal position. To complete the operation pull out and tear off the film tab or flap for the exposed film, thus bringing the next film into position ready for exposure.

The exposure times vary with the intensity of illumination, with the microscope, and with the nature of the specimen under observation, hence it would be impossible to suggest any limit. The optimum time for any one exposure can be learned only from experience. Using a 200-watt bulb as a source of illumination, the average time for exposures would probably be from 10 to 20 seconds. It is obvious that this exposure time will also depend on the distance the bellows is extended and upon the type of film used.

The magnification of a photomicrograph can be calculated after measuring with a centimeter scale the distance from eyepiece lens to the plane of the film pack in the adapter. This distance is called the projection distance. Substitute this distance, and the magnification of the optical system used in the microscope itself, in the formula: Image magnification=magnification of microscope × projection distance ÷ 25 cm.

OFTEN one would rather make a hurried sketch of a specimen under observation in the microscope rather than go to the trouble of taking a photomicrograph. One can do this very easily with the help of the camera described above. Set up the bellows in the usual manner but replace the ground glass plate with an ordinary clear glass plate of the same size. If a piece of fairly translucent white paper, such as tracing paper, is now placed on top of the glass the image of the specimen will fall on the paper in natural colors. It is a very simple matter to trace the outline of the image on the paper in a surprisingly short time, with the result that an accurate drawing with details all in true proportion is produced. Since the specimen is projected on the paper in natural colors it is feasible to produce a colored drawing, using wax crayons. Obviously one should attempt to draw pictures of this sort only in a room with subdued light, since the darker the surroundings the easier it is to see the

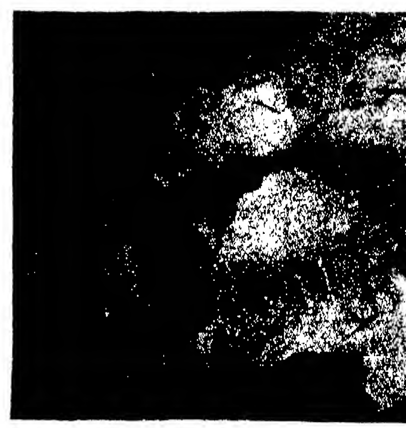
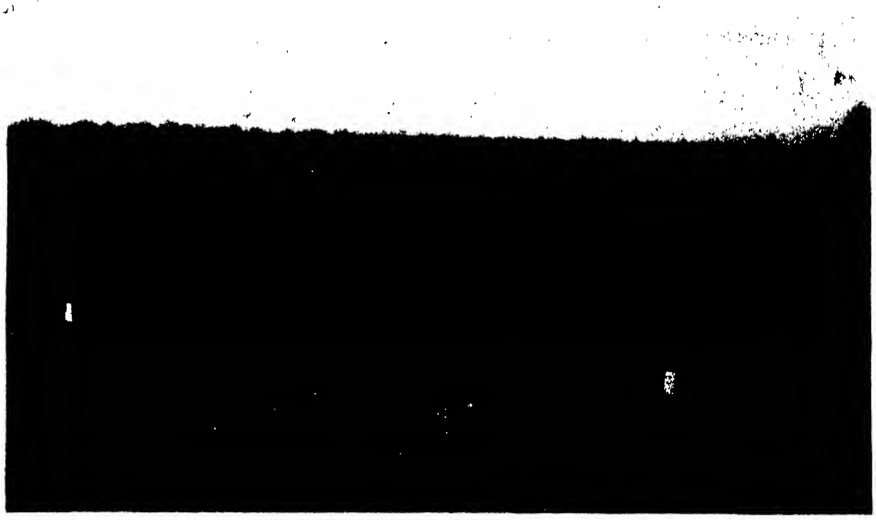


image on the paper. If this is not convenient it will be necessary to erect suitable shades around the apparatus.

MANY a research worker in chemistry, biology, and natural science has wished that he could photograph his interesting specimens. A photomicrograph is of great value, since it is the only definite proof of an observation; it is a permanent record.

During the last year or so microscopy has attracted a great deal of attention on the part of both the old and young, many of whom have adopted and fostered it as their chief hobby. To aid this group, numerous interesting articles have appeared from time to time, giving hints on microscope technique and suggestions regarding sources of interesting specimens. Perhaps the present article will add its mite.

RUBBER Plant Experiments By Federal Scientists



An experiment with guayule shrubs in California. These are perennials

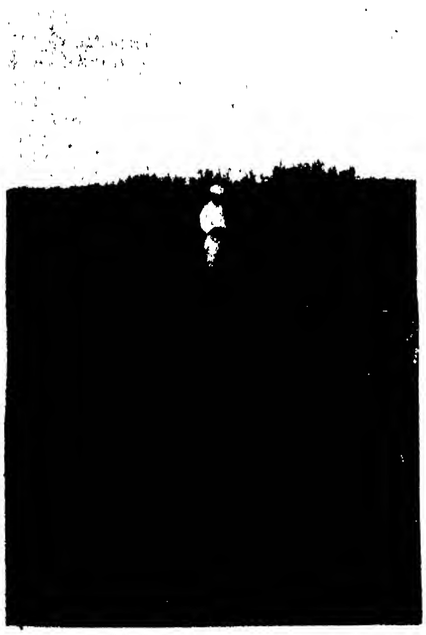
IF the price of raw rubber should ever be forced as high again as in 1923-27 under the Stevenson Plan, the United States will be in a fair position to produce a good share of its rubber requirements. Experiments by the United States Department of Agriculture—covering practically every important plant used for commercial production of rubber throughout the world—have singled out as the most promising sources for domestic rubber goldenrod, guayule, a shrub which grows well in the southwest, and *Hevea*, the rubber tree of the tropics. Of these, goldenrod is regarded as the most likely to develop commercially. The recent transfer to the Department of the Edison collection of goldenrod selections has given new impetus to the research program.

Rubber of good quality has been made from goldenrod, but the details of extraction and manufacture have not been developed sufficiently to produce rubber on a commercial scale. With present knowledge it would not be possible to make rubber from goldenrod at prevailing prices of about 15 cents a pound. However, experiments now in progress in the Department lay the foundation for domestic rubber production in case of an emergency.

Guayule is a shrub native to Mexico and southern Texas, which resembles sage brush and which can be harvested with machinery. Several thousand acres have been planted to guayule in California.

Other sources of rubber which could be developed in this country if the price were high enough to warrant it include the *Hevea*, the famous rubber tree of the tropics. The Department now has 30,000 of these trees growing in Florida, some of them from seed produced there. There is every reason to believe that they will yield as well as those in the East Indies.

Another rubber tree which grows well in Florida is the *Castilla*, from Central America. It is not so resistant to frost as *Hevea*, but it has a big advantage in that it yields a large percentage of its rubber at one tapping, a factor that would help to cut labor costs.



Two varieties—short and tall—of goldenrod plants in South Carolina

RUBBER made from guayule and goldenrod in this country so far has not been as good as the imported product. With continued improvement in methods of extraction, however, it is entirely possible that domestic rubber from these plants might be made to approximate that from the East Indies, in the opinion of L. G. Polhamus, who for several years has been engaged in a study of rubber plants for the Department of Agriculture.

So far, *Solidago leavenworthii*, one of the Edison selections, has the highest rubber content of any of the goldenrods analyzed. Specimens have produced more than 12 percent rubber. Another species, *S. fistulosa*, a selection by the Department, has analyzed as high as 9 percent rubber. A third species which yields from 4 to 6 percent rubber is considered promising because of its greater leaf production.

In spite of the popular interest in goldenrod as a source of domestic rubber there are many problems which must be worked out before we can look to this plant for commercial production of rubber, Polhamus believes. In the last few years he has laid the groundwork for genetic studies of the kind which are the basis of any intelligent breeding program. The Edison collection represents only a careful selection of outstanding individual plants. With the same scientific effort that is applied to the crossing of such plants as wheat and corn it seems reasonable to expect results with goldenrod far more promising than anything yet achieved.

Goldenrods are native to all parts of the country. Most of the plants studied for rubber production have been grown in the south, either in Florida or South Carolina, but it is entirely possible that plants from other sections would do equally well for making rubber. Cost of land and labor would be important items in selecting a locality for growing goldenrod commercially. The goldenrod experiments have not progressed far enough to warrant anyone going into the business of growing or collecting goldenrod to sell for making rubber.

To show something of the task facing him, Polhamus tells of planting a seed in 1932, from which a nice clump of plants grew in 1933. These plants he knew were genetically identical—which meant that they should behave alike. He harvested all the same day because he had learned that the time of harvest often influenced the percentage of rubber. They ranged from 1.07 to 3.55 percent rubber, in spite of the fact that they were genetically identical.

THE FIRST TENNESSEE

Excavations by CWA Workers Under the Tennessee Valley Authority Have Brought to Light on a Wholesale Scale the Contents of 40 Indian Mounds and Village Sites Soon to be Submerged by Reservoirs

THE archeological survey carried on by the Tennessee Valley Authority in the Norris and Wheeler Dam reservoir areas during the past year constituted an attempt to bring to light before those areas were submerged any data which the region might offer which would be valuable in solving some of the many problems facing the students of prehistoric records of southeastern United States. The areas subjected to examination were Anderson, Campbell, Union, Claiborne, and Grainger Counties, comprising the Norris area in northeastern Tennessee, and Lauderdale, Limestone, Morgan, Lawrence, Madison, and Colbert Counties, making up the Wheeler area in northern Alabama. The survey was conducted by Major W. S. Webb, formerly head of the Department of Archeology at the University of Kentucky.

At the outset, the survey was handled as a CWA unemployment relief project and financed by Federal CWA funds. Later, when Federal aid was withdrawn, it was carried forward and financed by state relief organizations. Sometimes as many as 800 men were employed in the work.

One hundred TVA-CWA workers began investigating the Norris reservoir area early last year. Two miles above Catham Bend on the Powell River in Campbell County, a series of open front caves were discovered. In one of these caves a number of primitive artifacts were found and eight skeletons exhumed. The human remains were discovered in completely flexed positions; that is, their knees were drawn up and both arms and legs bound tightly to the torso before interment. The remains were found lying in ash-filled hollows lined with bark. About the bones hung the remnants of a roughly-woven twine fabric in which the bodies had been wrapped.

None of the artifacts found in these caves indicate that these primitive peoples had ever had contact with the white race. Major Webb believes that these early inhabitants of the region were prehistoric Algonquin Indians.

As the examination of the region progressed, entirely different findings were reported. Mounds and village sites were discovered and excavated. The method of location is simple. The early inhabitants drew heavily upon the large supplies of shellfish along the rivers. The shells and the bones and refuse from game that had been killed were either buried in pits or scattered carelessly in the neighborhood of the settlements. In this unwitting manner, phosphorus was returned to the soil in considerable quantities, and this accounts for some of the unusually rich alfalfa crops in the bends along the rivers. Whenever Major Webb located an unusually fine field of alfalfa, he generally found underneath it the record of prehistoric occupancy.

Some 40 mounds were uncovered, enough to give a representative picture of the entire Norris reservoir region. Each mound marked the site of a village, and in the center of each a town house or "temple," ranging anywhere from 40 to 60 feet long by 30 to 35 feet wide, was in evidence. Extreme care in removing the overburden of earth was necessary in bringing the foundations of these buildings to light. Usually from four to eight feet down, a stratum of hard-packed clay was struck. Then the search for post holes would begin. When the buildings had burned down centuries before, they burned completely to the ground, leaving the stubs of the wall posts in the ground. The protruding ends of these stubs were carbonized and proof against decay, but the points under the surface soon disintegrated. When a ceremonial building burned down, the site was heaped with a layer of fresh earth and a new building constructed. (This reconstruction may not have been done by the same tribe; years may have elapsed in the interim.) With the disintegration of the stubs of the old wall posts, the fresh earth, whether laid on immediately or years afterward, forced its way down into the rows of holes. And when the archeologists lay bare the old temple floor, they look immediately for the long straight lines of round spots of earth colored differently from that of the main floor. These are carefully dug out with a trowel, and frequently the charred remains of the stub are found in the bottom.

te of Indian ceremonial building, Harris farm, Powell River, Norris Dam area—one few instances in which the "seat of authority" was not on east side of building

THE site of an early fortified village was unearthed near Caryville, Tennessee. (SCIENTIFIC AMERICAN, November 1934, page 248.) Foundations of the tribal temple, council room, and a portion of the stockade were brought to light. The temple foundation measured about 30 by 40 feet. In the center was located a raised baked clay altar with a fire pit in the center. The findings indicate that the walls of this building were thatched and about 10 feet high. The roof had been made by bending the tops of the young trees that formed the wall inward toward each other and then binding them together, thus forming an

Valley Authorities

By HERBERT F. GOUGH

arched roof. This too was thatched. Supporting posts for the roof were located at intervals within the building. Though this particular ceremonial building did not possess one, the floor of the one discovered directly underneath, and all the other temple foundations discovered in the region with but one exception, had a raised seat or dais with its back to what would be the center of the east wall. Thus, dais and ceremonial altar were always in a direct line facing the setting sun.

The semi-public building which stood near the temple was of the same construction, but had a flat fire pit rather than a raised altar. Adjacent was the site of a private building, typical of the dozens that must have formed the village. This covered a space of approximately 18 by 15 feet and was constructed of much smaller poles. Along one wall was a raised clay bench which evidently served as a seat for the head of the house. In the center was a small fire pit.

THE post holes marking the location of the stockade indicated that tree trunks at least 10 inches in diameter had been used in the fortifications. Occasionally this huge fence took abrupt right-angled turns, so that the face of the stockade could be protected by a cross-fire of arrows. The gateway had a protecting wall of poles in front, in order that no person entering or leaving would be in a direct line of fire from an enemy. It is thought that this Caryville village site, since it was the top and therefore most recent of several layers of superposed remains indicating several periods of occupation, may have been the Cherokee fortress that Colonel Montgomery saw and thought too strong to attack during his Colonial campaign.

Besides the temple site found at practically every mound, other representative findings were made. Large and small pieces of pottery were unearthed; some quite small, others at least 12 inches across at the mouth and equipped with handles. This pottery, typical of all American Indian pottery, is of the hand-coiled type. The pieces found were quite unadorned, except an occasional serrated edge or lip, and were unglazed. They were apparently made watertight, however, by the simple process of holding them upturned over a smudge and then rubbing into the rough-textured interior the accumulated lampblack.

Ceremonial objects, round stone disks or markers for some kind of game, and the customary run-of-the-mine artifacts were disclosed as well. At one mound a square, rather than round, raised ceremonial altar was discovered. This altar had a fire pit in the center, flanked on four sides by round shallow depressions—depositories no doubt for offerings to the four winds of heaven. None of the artifacts or findings indicate contact with white men.

Though as many as four levels of occupancy were discovered at some of the village sites, representing earlier and still earlier inhabitants of the region, no skeletal remains had been found in the mounds. A few dolichocephalic or long skulls were discovered in a crevice, which were identified immediately as being Iroquois. A final investigation at a site located along the Clinch River in Anderson County was decided upon.

The site turned out to be a burial mound, and 49 skeletons were found. Underneath the burial area were found indications that the spot had been occupied by a large public building. At one end of the burial area were found the charred remains of cedar logs that had formed a stairway. "It was the custom," said Major Webb, "to cover buildings with three or four feet of earth and use this roof for ceremonials. The cedar logs forming the ramp to the roof are the originals laid down by the Indians. When, in time, the building collapsed, the earth on the roof covered it, and later the same spot was used for burials." The bodies had been buried in the extended position rather than flexed.

The exact age of the prehistoric buildings uncovered in the Norris area, and the precise identity of their inhabitants, will not be known until later. These Indian remains are different from any hitherto found in America. "The men who built the round altars may have been early Cherokees and lived into historic times—until about 150 years ago. The presence of the square altar indicates Catawba influence," said Major Webb.

THE Cherokee nation built many towns throughout Tennessee similar to the walled villages of the Iroquois in the north. At one time a member of the Iroquois union of tribes, the Cherokees seceded from the Great League and migrated southward. In the southland they remained, a group of settled agricultural people surrounded by less civilized tribes. Their structures, intricate religious ceremonies, and compact political organizations bear out the traditions of their Iroquois forebears, whom the archeologists have termed "the Romans of the North American Indians."

Though a guess may be hazarded at the identity of the recent or topmost layers of remains, Major Webb refuses to make a definitive statement on the obviously earlier ones. For example, the old temple site found below the burial mound alongside the Clinch River in Anderson County is believed to date back long before the arrival of Columbus in 1492.

Site on Clinch River, near Clinton. Cedar log ramp mentioned in text shows clearly. No the skeletons purposely left in place on piers of earth when the ground was excavate

"The exact age of prehistoric buildings uncovered in the Norris area will be known within another year," said Major Webb. This will be accomplished with the aid of a dendrochronologist, one who reads the ages of trees from the rings shown in a cross-section of the tree. Samples of 23 logs from the ancient buildings have been taken, and of these the rings in nine can be read. Dendrochronological comparisons will be made with logs furnished by the Tennessee Valley Authority's Forestry Division from the oldest living trees of the same species in the region and from logs taken from old houses in the neighborhood. A present rough estimate is that many of the buildings had been erected around 1000 A.D.

"At least three vanished civilizations will soon be flooded in this area," said Major Webb. "One was very low in the human development scale; two were well up in barbarism, one extending into the history of our own country."

THE exploration of the Wheeler Dam reservoir area presented quite different archeological data. In this area alone there are 300 Indian mounds and village sites ranging in age from late historic to prehistoric times. In January, 1934, two parties of 60 men each began work in Lauderdale and Colbert Counties, and as the project progressed, the work gradually spread out to include all the counties falling within the reservoir territory.

One shell mound near Lock No. 1 along the Tennessee River in Lauderdale County yielded a very considerable body of information concerning the stratification of occupancy on this site, and also a considerable amount of skeletal material and artifacts, study of which should enable differentiation of the various levels of culture in the creation of this huge mound.

Numerous other sites were uncovered, the most important being two sand mounds on Tick Island in the Tennessee River, a village site on the Tennessee near the mouth of Cane Creek, and another on Hobbs Island in the Tennessee.

Some unusual finds were made in the burial mounds. The heads of several of the skeletons of children were found to be encased in huge conch shells, which had been split and then fitted back together around the heads. In these burials, the lower half of the shell was skilfully cut away to accommodate the deceased's head and neck, after which the upper portion was placed over the face and firmly cemented to the bottom part. That portion placed over the face was sometimes rudely fashioned into a face-mask, with tiny holes for the eyes and a crudely carved representation of the nose. The conch shells used in this burial practice are native only to the Gulf of Mexico. From this it might be inferred that much of the cultural influence on these tribes came from the south.

From the Caryville site mentioned in the text. A raised ceremonial fire pit

This inference is further substantiated by the finely fashioned stone pipes discovered in some of these graves. The stone pipes manufactured by the Indians at the spot now occupied by the town of Pipestone, Minnesota, were highly prized by all the tribes and have since been found in the remotest corners of the United States. These particular pipes, however, are finely fashioned, but are of entirely different stone.

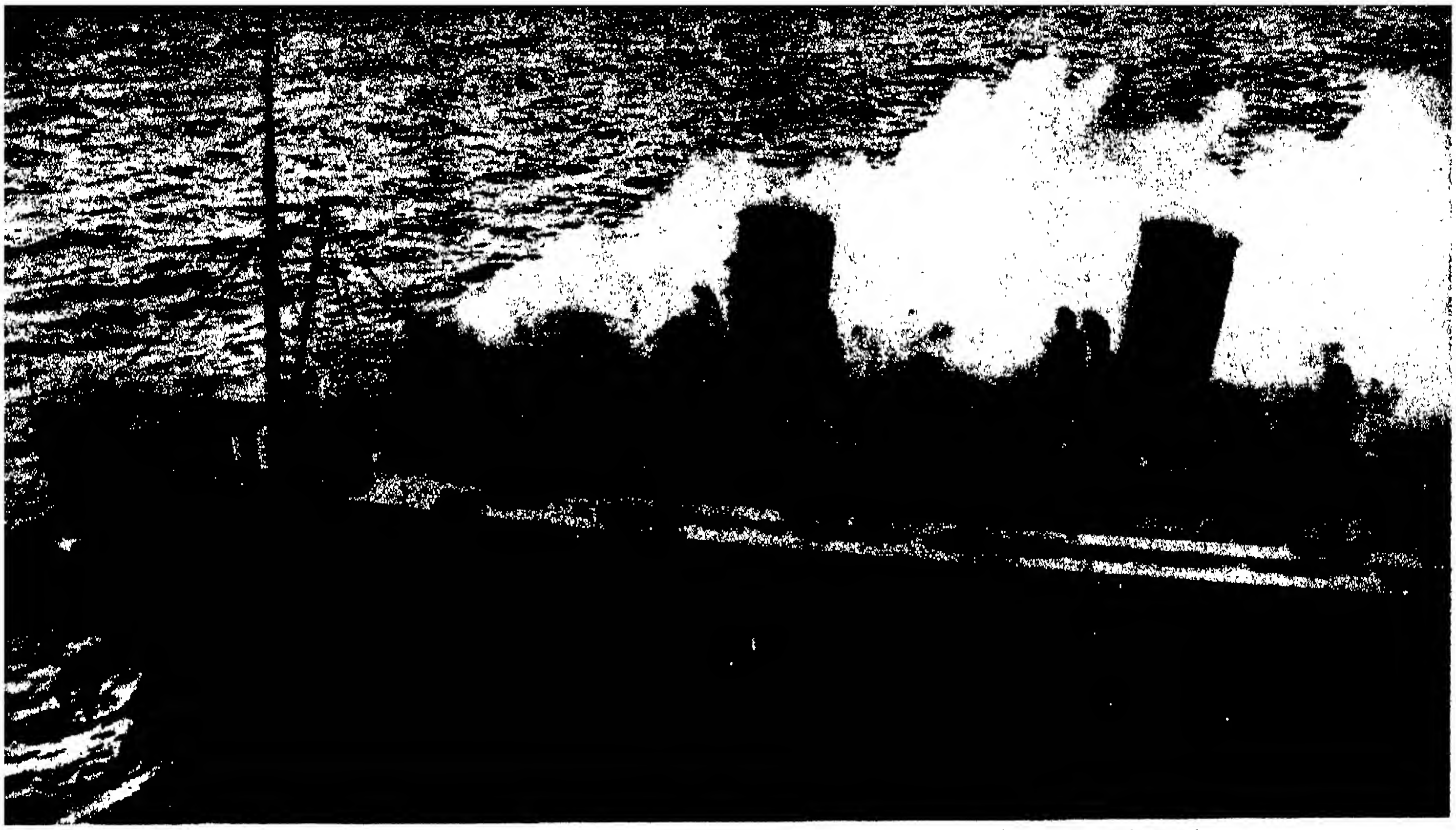
Two peculiarly shaped copper ceremonial objects were found in a depression immediately beneath one grave. They are flat and four armed, roughly shaped like the wooden creels upon which we wind string today. Only about six of these have ever been found in the United States, and all of them in the Tennessee area. It is believed that the native copper from the country up the river was used for these objects, rather than copper relayed by trade from the Lake Superior region, as is the case in some instances.

TO all appearances these races that occupied the Muscle Shoals area in prehistoric times were for the most part nomadic, being attracted to the neighborhood mainly by the presence of the large supplies of shellfish. There is little or no evidence of sedentary life, such as the walled towns in the Norris area. Two main groups of ancient peoples once lived in this area, archeologists believe. The oldest known lived long before historic times, were the most skilful carvers of stone pipes and other objects among all the American Indians, traded with shells, and buried their dead in stone-lined graves. The later inhabitants were the predecessors of the more modern Indian tribes. Some of the older village sites are believed to date back to the time when the bow and arrow had not been invented and the chief weapon was a dart given strong momentum by an *atl-atl* or throwing-stick.

With the close of the actual exploratory activity the findings were sent to various institutions for final accurate examination. The artifacts found in the Wheeler Dam region were sent to the University of Alabama, with the exception of the skeletal and pottery finds, which were sent to the University of Kentucky and the University of Michigan respectively. Relics from the Norris Dam area were sent to the University of Tennessee; the skeletons were sent to the University of Kentucky. Major Webb, himself, will offer an accurate and scientific monograph on the entire project as soon as final data from these institutions are available.

A square, raised ceremonial pit in one of the temple sites. Note four depressions mentioned in the article

The site of a structure in the Norris Dam reservoir area. This is where the "water tight pottery" was discovered



The tragedy of the *Morro Castle* might have been avoided by adoption of available safeguards

FIRE AT SEA!

By R. G. SKERRETT

Many Ships Are Firetraps . . . Personnel Inadequately Trained and Disciplined . . . Yet Fireproofing and Full Protection Possible . . . Aroused Public Opinion Needed

WILL the horrifying loss of the S.S. *Morro Castle* lead to corrective measures that will make for greater safety at sea? Or will the virtual destruction by fire of that comparatively new ship and the sacrifice of 137 lives remain just one more appalling blot on the record of our Merchant Marine? Are we to understand that such tragedies are inseparable from ocean-going travel, and that naval architects and other technicists have not made possible greater security of life and property afloat? We can answer these questions only by analyzing the contributive causes of that disaster and show what can be done to make a recurrence more or less unlikely.

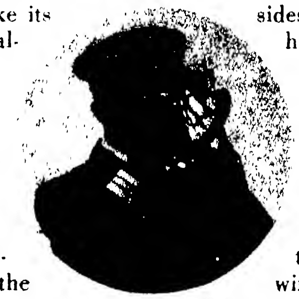
The files of SCIENTIFIC AMERICAN will disclose how, over its many years of service to the public, it has earnestly and repeatedly urged the adoption of practicable measures that would promote safety at sea. Its position now is that the catastrophe that befell the S.S. *Morro Castle* and the people aboard her could have been avoided, and that human fallability was, in the main, responsible for the conflagration reaching an uncontrollable stage. Harsh and deserved criticism will do no good now—there are constituted authorities that should place blame wherever accountability lies: our function is to point out how the menace of fire can be very much lessened on vessels designed primarily for the carriage of passengers in considerable numbers. To this end, we must first examine the ship and her equipment; and then we must weigh the part that must always be played by her personnel in her proper administration or operation either when things are running smoothly or when the presence of fire aboard creates an emergency calling for prompt and trained collaboration.

THE fire hazard in modern merchant ships, and especially aboard the de luxe liner, has led to extensive investigation, to the devising of numerous protective features and instrumentalities, and to a somewhat voluminous literature that is revealing of how much study has been given to the problem. Furthermore, various branches of our engineering and industrial life have contributed dependable apparatus for the early detection of fire, and have provided effective means for smothering or extinguishing flames, as well as structural materials that can be relied upon to resist the spread of fire long enough to give an alert personnel a very fair chance to bring the fire-fighting equipment into action effectually and decisively. No experienced naval architect or seafaring man believes it economically feasible to build and to operate profitably a craft that is 100 percent fireproof. On the other hand, there are those of experience that are convinced that a passenger ship, for example, can be made so far fire-resistant that flames can be held in check and the vessel safeguarded from extensive damage.

The modern express steamship which, for our purpose, also means the motor ship, earns money for her owners by transporting both freight and passengers. The freight or cargo, no matter what its character, is commonly stowed in steel-walled compartments that are kept sealed between ports. Should fire develop within any of these closed spaces, it is a comparatively simple matter to fill the endangered space with steam, inert gas, or, in some cases, to

admit water to extinguish the fire, or at least to confine it to that single subdivision of the craft.

The up-to-date liner is equipped with some kind of automatic fire-detecting system that indicates at one or more continually attended stations just where the danger has developed in a cargo hold, a storeroom, a fuel bunker or any kindred space, and within a minute or two a volume of inert gas, for example, can be turned into the area to smother the fire or to make its spread extremely slow—really progressive smoldering rather than flaming. Again, in the well-equipped liner there is an automatic fire-detecting system that stands guard continually over the quarters of the ship's personnel and the cabins of the passengers; and should fire develop in any of these spaces, men assigned for the purpose in each division of the craft can hasten at once to the endangered area and deal with it with means provided for that purpose.



THE *Morro Castle* had fire-detecting systems extending to all the structural subdivisions enumerated in the foregoing paragraph, but, by the irony of fate, no such automatic detectors were placed in the public or recreational spaces designed for the convenience of the passengers. It was in one of those spaces that the fatal fire was first located and, according to reports, inefficiently attacked. Possibly, had the ship had automatic detectors in all those spaces the fire might have been discovered sooner; but, even then, it is an open question whether or not the flames had originated somewhere else within the structure and spread there insidiously—acquiring the while a headway that made their onward progress irresistible.

Safety regulations for the arrangement of present-day passenger liners require the interposition of athwart-ship steel bulkheads, with suitable doors, that divide the passenger accommodations into unit areas intended to check the advance of fire from one division to another forward or aft of the zone on fire. But this is, at best, only a partway safeguard and would hardly do more than slow up disaster if the entire affected area became inflamed. The safety of a ship exposed to fire in her passenger accommodations can be reasonably assured or minimized only by the adoption of structural changes that will reduce to a marked extent the quantities of inflammable materials in those sections of a vessel that will make each stateroom or each public space a self-contained unit having walls, ceiling, and floor that are in themselves fire-resistant. Furthermore, ways and means must be provided that will restrict or choke drafts that contribute to the propagation and the spread of flames.

Because of its inherent lightness, comparative ease of working or shaping, and because it lends itself readily to painting or some other surface finish, wood is usually employed to form the partitions, paneling, and cabinet work found in staterooms and the public spaces of a liner. The structural steel framework overhead and along the sides of a ship are generally hidden behind carpentry work. To support that finish, furring or grounds of wood are interposed between the steel and the paneling, ceiling, and so on. It is within the intramural spaces so formed that piping and electric wires for a diversity of services are run. We have a counterpart in our own homes. On shipboard, these intra-mural channels contain fuel and induce insidious drafts that feed and encourage the spread of a fire. Thus a conflagration may attain dangerous proportions even before it comes out in the open and is discovered. Inflammable furniture in a passenger stateroom may be the means of propagating fire started by a cigarette, a cigar, or a match disposed of carelessly.

For these reasons, all wood backing should be chemically treated to make it fire-resistant or be supplanted by light metal that will serve the same purpose; and the walls of a stateroom should be of fire-resistant materials extending from the floor or deck up to the deck or beams overhead to isolate the cubicle and thus prevent drafts along the ceiling.

IN an effort to win patronage, the public spaces of some de luxe liners of today have many of the characteristics of accommodations found in overly elaborate hotels. The architectural embellishments are usually fashioned of wood and, of course, are highly inflammable; while the interior decorator provides appointments that are just that much more fuel for flames. As has been well said, probably most travelers do not feel at home in that setting, and the lavishness of those places is unnecessary and an invitation to calamity. In the case of a hotel, similarly appointed, such a hostelry would be found in a city boasting a fire department manned by a thoroughly trained personnel. On none of our merchant ships, up to date, is such a force at hand to battle with a fire.

It has been argued by naval architects of acknowledged standing that the cost would be high, if not prohibitive, to rearrange the passenger accommodations and the public spaces aboard any of our well-known liners so as to reduce materially the fire risk on them. To some extent, this may be true even though extremely regrettable; nevertheless, steps can be taken and the means are at hand to lessen the peril on those very vessels. On the other hand, it is a heartening fact that there are in service today modern express steamers that have been so designed, built, and equipped in their passenger accommodations that fire originating in a stateroom or in one of the public spaces would have little to feed on and only a slight chance to attain dangerous proportions before the fire-fighting apparatus could be brought into action.

THE conservative naval architect—one who would still cling to a wide use of untreated wood—justifies his stand on the basis that the employment of metal or fire-resistant materials would add excessive deadweight to the above-water body of a ship and make vexatious the problem of giving to the craft comfortable motion and the desired measure of stability in a seaway. According to other experts, a large liner can be immensely improved in the matter of her structural defenses against the spread of fire without adding to her deadweight more than 1 percent; and there are still others who are convinced that even this allowance for the sake of added security is an excessive estimate. Of course, best success in this direction can be realized only when the ship is designed from the very beginning with a full knowledge of the materials that can now be had for use in place of inflammable lumber; and the increased cost, if any, would be relatively small and well worth the while for the protection thus afforded.

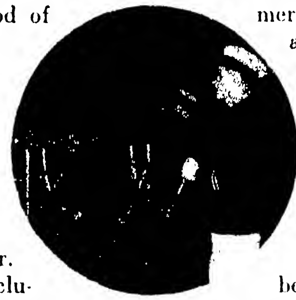
Metal furniture (aluminum) and fireproof paneling aboard ships, as they are used in this cheerful, modern dining salon, greatly reduce fire hazard

Smoke pouring from one tube of this fire detector (right) indicates compartment in which fire is located. Below are shown containers of fire-smothering inert gas on the *Europa*

Rear Admiral George H. Rock, formerly chief constructor of the United States Navy, is an outspoken advocate of steel partitions in place of wooden panels, walls, etc. It is his opinion that lightweight stainless steel, fabricated for the purpose, can be employed, where lumber is now used, and afford all essential strength and resistance to fire. He has pointed out that steel so fashioned would cost less to maintain in proper condition than any combustible material today utilized.

It is not possible in the space now available ~~for the~~ general presentation of our subject to enter into details such as has been done by technicians in this country and abroad. Let us, however, touch briefly upon certain conclusions arrived at by George G. Sharp, naval architect of New York City, who, besides designing a number of ocean-going liners especially constructed to resist the spread of fire, has also carried out a series of tests on a sizable scale for the purpose of definitely evaluating a number of materials developed commercially to minimize the fire hazard within the passenger spaces of vessels. These also included the testing of metal furniture to replace furniture of wood, commonly found on shipboard. The investigations established the relative adaptability of steel, fireproofed wood, aluminum, asbestos, combinations of asbestos and aluminum, felt-bonded metals, and the non-inflammable panelings of phenolic resin and Micarta plastics. (See "Plastics Come of Age," January, 1935, SCIENTIFIC AMERICAN.—*The Editor.*)

THE purpose was to ascertain how far these different materials could be employed in constructing three different classes of bulkheads, each capable of affording a prescribed measure of fire-resistance at given maximum temperatures and for fixed periods of time. The assumed temperature of a briskly burning fire is 1700 degrees Fahrenheit; and in the tests conducted by Mr. Sharp and his associates, the so-called A-1 bulkhead resisted a temperature of 1500 degrees for 60 minutes; the A class bulkhead withstood a fire for 30 minutes when exposed to a temperature of 1500 degrees; and the B type bulkhead survived a temperature of 1000 degrees for 30 minutes. In every case, the resistance to combustion was such that fire could be held at bay long enough to bring fire-fighting facilities into action with measurable promptness and with every reasonable likelihood of extinguishing the flames.



The objective in developing the foregoing bulkheads was to produce those that would make for simpler construction while increasing the defenses against the spread of fire on shipboard. Mr. Sharp reached this conclusion: "In the matter of simplification of the methods of construction, it may be assumed with reasonable confidence that by making a fresh start in the consideration of this problem, economies can be effected that will wipe out any adverse balance which might, in the light of existing practices, seem to be inescapable. Of course, such economies as might be effected would in some measure also apply to construction using untreated panels, but it seems fair to credit the economies effected by the advancement in the art to the production of a means for controlling an outbreak of fire." In short, this designer, as a result of what he has already accomplished on certain modern ships, is convinced that any added cost involved in increasing resistance to fire in the ways he proposes will be more than offset by resulting benefits.

The point to be emphasized is that there are today available sensitive apparatus that will give instant warning of the presence of smoke or an alarming rise in temperature in any compartment or subdivision of a ship and indicate in some manner where the danger lies. Again, measures have been devised by which flame-promoting drafts can be localized or choked; and by the use of structural materials of approved efficiencies the spread of fire can be checked for considerable periods. Furthermore, fire-fighting mediums in the form of automatic sprinklers, inert gases, steam, and the like, are at the disposal of the naval architect when planning for the security of a vessel.

IT must, however, be recognized that carelessness, a short circuit, and various other causes may lead to a fire in the passenger accommodations of a liner regardless of regulations, education, or other precautions relied upon to promote safety at sea. In any case, ultimate security rests upon the personnel of the craft concerned and the promptness and skill displayed by the officers and crew in combating a fire. The flames must be fought in their very earliest stage, and the attack must be an understanding one that shows preparatory training. This state of readiness and efficiency is reported to have been woefully absent aboard the S. S. *Morro Castle*. We wonder how much better are discipline and fitness for a kindred emergency on other of our merchant fleet. In the last analysis, responsibility rests squarely upon the Government and its statutory agency, the United States Steamboat Inspection Service.

The so-called short cruises offered by passenger steamship lines have become popular with our people. Of these relaxing trips, Rear Admiral Bradley A. Fisk has written to *The New York Herald Tribune*: "American men and women have been going to sea on the most shocking and irresponsible 'joy rides' on board vessels about whose seaworthiness, fire prevention methods, and other matters they knew nothing whatever. They had . . . some vague notion that there were some kinds of laws which made it perfectly safe to go to sea in American

(*Please turn to page* 110)

The Versatile Papaya

A papaya plantation in Florida, showing the "bunches" of nearly ripened fruit hanging just under the lower branches

Used as Breakfast Food . . . In the Manufacture of Rope . . . For Medicines and Cosmetics . . . 'A Melon in a Tree'

By FRANK A. MONTGOMERY, JR.

IF you are somewhat tired of the constant procession of oranges and grapefruit and similar products of the fruit grower's art that march endlessly across your breakfast table, and have an adventuresome spirit that calls for something "different," you might, quite possibly, do worse than vary your fare with a papaya. Your fruit dealer or neighborhood groceryman might look puzzled and inform you that there is no such product. But don't you let him fool you. For he should know better, and recognize in the papaya, or tree-melon, that delicious product of tropic lands that is rapidly coming to the fore as not only a delicious breakfast food, but also as a source of many useful products to mankind.

In fact, the varied products of this unusual member of the plant world are fully as striking as the strange appearance of this tree in fruit. The papayas are borne upon long stems that issue directly from the trunk near the topmost leaves. For example, the bark of the papaya is used in the manufacture of rope, while the roots yield a juice that is said to be an excellent nerve tonic. The seeds are eaten as a delicacy and the natives of the tropics quite often chew them to quench their thirst. The ripe fruit finds a place as a most pleasant substitute for the prosaic cantaloupe, while, in a green state, it may be cooked and eaten as a vegetable. Then, too, when a tree has become unproductive at the end of approximately three years, and is cut down, the soft, pithy heart of the tree is carefully removed and grated and served in just about the same manner as a cocoanut. The flavor is somewhat different from that of the cocoanut, but in appearance and general characteristics the heart of the papaya tree might easily be mistaken by the unsuspecting for grated cocoanut.

Sliced and served with whipped cream, papayas make a delicious dessert; in combination with lettuce and sliced cucumber, a wholesome and nourishing salad. Marmalades and jellies made from the fruit are greatly relished, and for pies, shortcakes, sherberts and pickles, those familiar with the fruit want nothing better. On the other hand, crystalized papaya cubes, if prepared carefully, make some of the best candies that can be prepared from tropical fruits.

But more interesting than the fruit of the papaya (and it is for this product that so many of the commercial plantings are being made in the tropical sections of the United States) is the milky juice that is obtained principally from the fruit while it is still green. This juice, in its natural state, is used by the natives of the tropics in the treatment of eczema, warts, intestinal worms, ulcers, and many kinds of sores, in diphtheria, and for numerous other ailments.

The ripe fruit is used as a cosmetic, a slice of it being rubbed upon the skin to remove freckles and other blemishes. Face powder and many lotions for care and treatment of the skin are produced from the papaya. The green fruit and the leaves are employed as soap to remove stains from clothing.

EXCEPT for food, and the production of papain for the drug trade from the fruit, no single use of this plant is so common in the tropics as that of the milky juice in rendering tough meats tender. For this purpose a slice of the green fruit, rich in juice, is rubbed over the tough meat, or the latter is dipped for a few minutes in a solution of the juice itself. Sometimes a piece of the fruit is placed in the water in which meat is boiled. Another way to utilize this long-used property of the papaya is to wrap the meat in the leaves. Some stock raisers, it is claimed, even feed the fruit to their hogs to make the pork more tender!

The reasons for this unusual quality of the papaya for rendering tough meats tender lies in the fact that the juices of the tree are rich in papain, which is a product possessing the power of digesting protein materials such as meat, egg white, the curd of milk, and so on. The action is similar to the two well-known body-ferments in the human stomach, pepsin and trypsin. On account of the efficiency of papain, it is largely replacing pepsin in the drug field.

The method followed in obtaining this valuable papain is to dry the milk that exudes from the rind of the green papaya fruit. The milk containing the papain is best obtained from the nearly full-grown, well-developed green papayas by scratching or making shallow cuts in the rind with an ivory, wooden, or bone knife. Very young fruits give a milk that is rather weak in digestive power, while the ripe fruit gives very little, if any, milky juice.

The juice that flows from the cut on the fruit is collected in a glass or china vessel, which must be scrupulously clean. After a short while the bled fruit will cease to flow, due to coagulation of the milk in the cut. In a few days, however, the cut heals over, and, apparently, the process has little effect upon the quality of the fruit produced. Additional cuts may be made in the fruit every four or five days, or until the fruit shows signs of ripening. Under no conditions are steel knives used for making the incisions, as the resulting papain will be of a dark color, and of little value. The tapping is done in the early hours of the morning, and is always finished before 10 o'clock, which gives plenty of time for drying the same day.

SHORTLY after collection, the whole mass of juice coagulates, forming a pure, white curd. This must be rapidly dried lest decomposition should set in, completely spoiling the material. Drying is accomplished by many producers in the tropics by simply spreading the curd upon glass sheets and drying in the sun, and while it should be done without delay, too rapid drying results in an inferior product. In Ceylon, especially, where, on the southwest side of the island, weather conditions are usually rather uncertain, drying the juice cannot be done outdoors. In this locality, and on many of the larger plantations in other parts of the world, special drying apparatus is in use. A good average yield of papain from an acre of papayas is 175 pounds of powder yearly.

A noted health expert has this to say about the papaya: "I have been especially interested in investigating the vitamin content of the papaya. Work done in Honolulu and the Dutch East Indies indicates that the papaya is rich in vitamin C, which makes the orange so valuable, and is very rich in vitamin A. This last vitamin is rare in fruits, and is generally associated with vitamin D wherever found. Vitamin D prevents rickets, so for this one reason alone the papaya should be of inestimable benefit to the people of the world. Also, because of its powers to aid digestion of foods, it should prove a boon to sufferers from the various forms of indigestion.

"The study of the papaya from a health standpoint has only just begun, in spite of the fact that its medicinal virtues have long been known to dwellers in the tropics, where the fruit grows wild. But the facts already known indicate that the papaya possesses qualities which make it capable of rendering a priceless service to the people of the United States."

THE papaya belongs to a genus of about 20 species which are native to tropical and sub-tropical America, with the common species (*Carica papaya*) occurring naturalized through the keys and hammocks of south Florida. The plant has been carried around the world, however, until it is known throughout almost all tropical regions. All the species are of rapid growth, making unbranched trees up to 30 feet in height, which are of striking appearance, with large leaves and abundant melon-like fruit, giving the plant a singular and characteristic aspect. The fruiting is comparatively continuous over a period of three or four years. The fruit ranges in size from the size of a quart measure to that of a large water bucket, and weighing from three pounds to as much as fifteen. Many species are round in shape, while others are elongated, and these, incidentally, are the best type for shipping.

The problems of the cultivator are several. The first one, and that which has caused the greatest difficulty in selling the fruit for food purposes, is the problem of establishing a strain of papayas that are of high and uniform quality. The papaya produces three types of plants bearing, respectively, staminate, pistillate, and perfect flowers. The first are useless for fruiting, and the second must be pollinated by male or perfect flowers.

A small papaya tree flourishing in the yard of a Florida fruit grower

It seems rather unfortunate that a plant with so many possibilities for culture in the tropical portions of the United States, especially southern Florida, should be surrounded by so many perils. Being strictly tropical, the papaya must be grown out of reach of freezes. It can not stand flooding or a high water level, yet requires a constant supply of moisture. On sandy lands it is subject to root knot, but it can be managed in such places as an annual crop. Its leaves may be attacked by a leaf fungus, but this is controlled by means of regular spraying. The greatest danger to the grower, however, lies in the activities of the papaya fruit fly, an insect that deposits its eggs beneath the skin of the papaya, where they later hatch and prey upon the pulp within.

For a fruit which has so many qualities to recommend it, it is but natural to run to superlatives in describing it. But fortunately the papaya, not being human, cannot be injured by so much praise, for which we should be grateful. One lover of the fruit will praise its delicious taste as a food; another will rave endlessly about its marvelous digestive properties; while still another will run wild upon the subject of its many odd, and, seemingly, unrelated uses. But after all the papaya is nothing but a melon, and the fellow who said that it struck him as being a "glorified melon which has climbed into a tree to display its superior qualities," certainly hit the nail upon the head.

Ripe papayas. In the sectioned fruit at the right may be seen the location and arrangement of the numerous seeds, uses for which are mentioned in the text

LET US DIE FASHIONABLY

By T. SWANN HARDING

SOMETHING a doctor friend said to me recently gave me the idea expressed in that rather curious title. I was bemoaning our increasing death rates from heart disease and cancer. I said I hoped I should not die of cancer. It was then that the physician remarked:

"You will probably die fashionably."

"Fashionably?" I gasped.

"Certainly. What is so extraordinary about dying fashionably? Who ever died of appendicitis in 1875? Look how many people die of it now. I tell you certain diseases become fashionable. I mean by that, that they are recognized as diseases, doctors grow somewhat enthusiastic over them and then patients begin to die of them."

"But statistics do show that our death rates from heart disease and cancer are becoming most alarming."

"FIGURES don't lie," said the doctor, "but statistics are figures that have grown up and learned how. In the first place, who is it that says anybody dies of anything? The physician who signs the death certificate. Why does he say, for example, myocarditis, a form of heart disease, or cancer? Often, I tell you, because it is the thing uppermost in his mind, the fashionable thing. I just came from the autopsy of a man who died of diabetes, according to his death certificate. But he had an infected leg. His heart gave out. Worse still he had an inoperable cancer in his abdomen. What did he die of? If he had not gone to autopsy the attending physician might have written any of three or four things and been right, to some extent. Suppose he was interested in heart disease and it looked like endocarditis to him. Would this man have died of diabetes? Look it up some time. You will find out I'm right. And, as for you, you are almost certain to die fashionably, whatever else you do. Cheerio."

"What are diseases?" Our bodies are invaded by organisms and they produce symptoms as their reply. These replies have various names—measles, scarlet fever, whooping cough, and so on. These are called diseases and they are classified in various ways. No scheme of classification can possibly be perfect, and diseased conditions constantly arise which will not fit into existing schemes under existing labels.

The doctor confronts a living patient. He observes certain symptoms. He classifies and concludes that the disease is such and such. Why? Assume that there are ten symptoms to be expected as evidence of a certain disease, say influenza. Of these, seven are invariably found in influenza, but the other three are found also in pneumonia. There are overlapping symptoms. You can see easily that there is a margin for free judgment here.

WHAT would you call a classic picture of influenza? A case with seven of the symptoms, a case with but six, or a case with eight? A point is soon reached where one physician would say influenza, another influenza-pneumonia, another la grippe and still another coryza, perhaps. Suppose the patient dies. What shall be assigned as the cause of death in the certificate? Suppose now that the patient had a weak heart and that he died suddenly of heart failure?

I began to see how it would be possible for a person to die fashionably.

Indeed, Dr. B. Henry Mason told the American College of Surgeons in November, 1930, that, upon reviewing the cases in New England hospitals, he found errors in diagnosis in from 20 to 75 percent of all that had resulted in death. He said that gross errors were made in 20 percent of the cases and he urged that autopsies be performed on every dead body, because only thus could we begin to get an accurate idea about causes of death.

So a disease is, after all, not so much what a person dies of as what his doctor thinks he died of, or what he certifies as the cause of death. Therefore mortality statistics based on death certificates may mean little.

Because we hear so much about it, let us take heart disease as an example. In early 1932 Dr. Robert H. Halsey published an article that caught my eye. For one thing I discovered that there is such a thing as "The International List of Causes of Death." You practically have to die of something listed in this list or else lose caste as a corpse. But in 1919 you could have died of only four kinds of heart disease:—Pericarditis, endocarditis, acute myocarditis, or angina pectoris. If the death could not be shoved into one of those classifications—well, you simply died of "Other diseases of the heart."

But in 1929 the same list was much expanded. The four causes remained, but one could also die of "acute" or of "unspecified" endocarditis, not to mention "chronic unspecified" and "chronic specified." It was also possible in 1929 to die of conditions such as "chronic myocardial degeneration," or "disease of the coronary arteries." Finally, under the old classification, "Other diseases of the heart," were to be found, "*a:* Functional," and "*b:* Other and unspecified." So I saw that a person might die of what might be called one type of heart disease one year, which might be quite another disease ten years later.

I ALSO found that in the years 1804 to 1808 no deaths from heart disease were recorded as occurring in New York City. Only in 1868 did attention come to be directed to the matter of classifying causes of death for statistical study. A list was then adopted. It was revised every 10 years. Now in 1924 when the 1919 list mentioned above was still effective, only 10.6 percent of all deaths from heart disease were classified specifically; the other 89.4 percent were thrown into the omnibus drawer called "Other diseases of the heart." Things were just about the same in 1927, meaning that specific diagnosis was uncommon.

But the list expanded, as we observed. Yet, while in 1929 figures collected under the old listing classified 91.8 percent of all deaths from heart disease among "Other diseases of the heart" (which means essentially nothing), the figures for 1930, reported under the new listing, so classified only 4.3 percent of the deaths! Why? Had heart disease changed? No, but the classifications had. Physicians had become aware of new labels for varieties of heart disease. These new classifications became fashionable. People at once began to die of them.

Am I drawing a long bow? I think not.

Take myocarditis, for example. The myocardium is the muscular part of the heart wall; myocarditis is a very acute inflammation of that wall. In 1914 Dr. R. C. Cabot asserted that his studies of 3000 necropsies had demonstrated that myocarditis was "recognized" in living patients six times as often as it could be found in dead ones. That seems to do quite well for recognition of something that is not there.

In 1908, however, the famous heart specialist, Sir James Mackenzie, had very emphatically called attention to the importance of the myocardium. He at the same time deprecated the great weight then given by physicians to valvular damage. What happened? Almost immediately the registered deaths from myocarditis increased rapidly and significantly, and those ascribed to valvular disease dropped off.

As Dr. Halsey writes, "It was apparent that physicians of the State could become 'myocardial minded'. . . . It was almost certain that there was no such change in the actual incidence of myocarditis or valvular disease. . . . These tabular changes evidently result from the demands of 'style,' 'vogue,' or 'fashion' in medical thought. . . ." Names and classifications change. Then people die of newer and more fashionable diseases. Shall we soon read in the advertisements: "Die of endocarditis! It is the latest thing in the smart set of business men. To die of endocarditis is to die fashionably."

Nevertheless in 1930 the deaths from heart disease in New York State were 23.6 percent of all deaths. Deaths ascribed to this cause were only 1667 less than the sum of all deaths ascribed to cancer, tuberculosis, and pneumonia put together. What about that? Or we read an article about cancer. It says that the death rate from cancer in 18— was — per 100,000 but that today it is —— per 100,000. That looks nice and impressive, especially if illuminated with charts and graphs. What about that?

Well, what is heart disease? "Is the 'appalling increase' in heart disease real?" That, by the way, is the title of an article by Drs. Charles F. and Nils W. Bolduan of the New York City Department of Health. I read this and immediately discovered that what had increased was the number of deaths from heart, kidney, and arterial ailments. But while a great deal has been said and written regarding "the rising tide of heart disease," it appears that no one has so far taken the trouble to determine whether the tide is really rising or not. The *basic data* are death certificates filed by physicians who classify deaths "fashionably" under the causes of death listed in the international classification list.

Statisticians in health offices really

Growing Death Rate From Cancer and Heart Disease . . . Is It Real or Only Apparent? . . . Why Our Alarm May Be False . . . Inaccurate Reporting of Cases by Earlier Physicians . . . Better Reporting Today Reveals More of the True Cases

use this list more conscientiously than do doctors. What happens is this: A death occurs. The physician certifies the cause of death. Here are five specific cases as they left the physician—

1. Chronic organic heart disease; chronic Bright's disease; arteriosclerosis; cerebral hemorrhage.
2. Diabetes; pneumonia; myocarditis; coma.
3. Chronic Bright's disease; diabetes; pulmonary tuberculosis; anemia.
4. Acute endocarditis; subacute nephritis; acute articular rheumatism; uremia.
5. Chronic heart disease; pneumonia; fall down stairs; fracture of leg.

The health office statistician reads something like that and then has to classify the death under one cause in the international list. Which of the causes should take precedence? Having decided upon heart disease, which kind thereof shall it be? Perhaps the one that is most fashionable, most talked of at the time.

When the heart, kidneys, and arteries are all involved it is almost impossible to say what, specifically, a patient died of. But this is true: While there has been a registered increase in the death rate from heart disease, there has been, in recent years, a corresponding reduction in registered deaths from other causes that might easily be mistaken for heart trouble. I mean that, hand in hand with a registered increase in the death rate from heart diseases, there has gone a corresponding decrease in registered deaths ascribed to apoplexy, kidney disease, and old age. That is very significant.

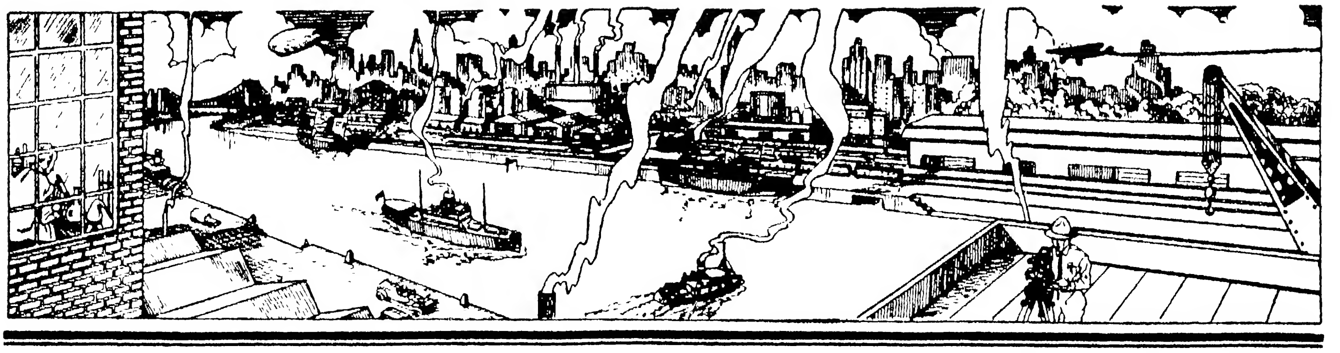
The registered death rate from heart disease has risen, but that rise is largely if not wholly fictitious—so write authorities. This is because statistics based on the registered deaths from heart disease alone are necessarily fictitious. This means that apoplexy, arterial disease, kidney ailments, and senility must be regarded along with heart disease as causes of death, and there is great prevalence of the first three in the United States. But the mere fact that specific death rates in the higher age groups have declined in this country since 1900 alone proves that there can not have been any considerable increase in mortality from heart disease.

So it became apparent that one could not trust mere printed statistical statements of alarming increases in deaths from this or that disease. Fashion had a hand in the classifications. Heart disease is too often accompanied by kidney and arterial involvements to be a real disease entity. Many deaths attributed to the heart are undoubtedly caused by pathological conditions elsewhere.

Somewhat the same condition exists with regard to cancer. Cancer is difficult to diagnose. Even physicians often mistake it when they themselves are their own victims, while 50 percent correct diagnoses of cancer on living patients, with every modern clinical device available, is about as well as can be done. Surely the conditions diagnosed as cancerous, and from which our nearer and more distant ancestors died, may or may not have been cancers at all. What does this mean?

It means, for one thing, that we do not today know the true mortality from cancer. Our best statistics are adulterated with faulty diagnoses. It means also that we cannot compare our present with our past cancer death rate in this country because older statistics are even faultier than those of the present. We actually do not know whether the prevalence and the morbidity of cancer are increasing or decreasing, and this despite what well intentioned fanatics would have us believe.

Dr. Francis Carter Wood, Director of the Institute of Cancer Research at Columbia University, says our available cancer statistics are based upon the same old death certificates and that they therefore contain uncorrectable errors carried over from the primary documents—the certificates. These, as we have seen, are of little value. Hence the reports of the Bureau of the Census can rise no higher in accuracy than the faulty death certificates from which they are derived. The mere summation of data and their dramatic presentation in the form of graphs or tables do not impart to the basic sources the character of infallibility. It may astonish those who bow down and worship statistics to know that the records err by from 30 to 40 percent. The only sound method of obtaining accurate statistics is to base them not upon fashion and vogue, but upon autopsy findings.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

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Research on Twins

IN a study of the influence of heredity and environment, Prof O. von Verschuer of the Kaiser Wilhelm Institut für Anthropologie at Berlin has divided twins into three groups: (1) those with the same heredity and environment, (2) those with the same heredity but with different environment and (3) those with different heredity and the same environment. A comparison of groups 1 and 2 shows the degree of environmental influence, that of groups 1 and 3, the degree of hereditary influence.

Influence of Environment and of Heredity

	Environment	Heredity
In body weight	85 percent	169 percent
In chest circumference	70 percent	165 percent
In height.	18.5 percent	192 percent

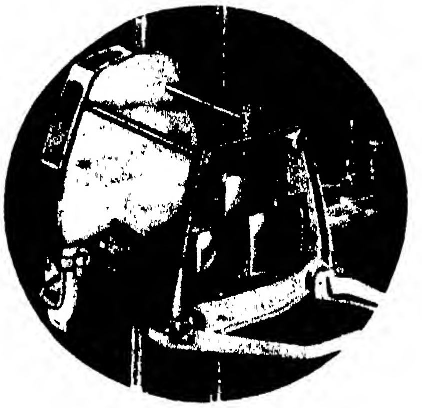
—*Journal of the American Medical Association.*

Checking Up on Headlights

A NEW device for testing and adjusting automobile lamps with scientific accuracy and at a range of only 18 inches, is attracting interest in the automotive service field. The new machine, developed by R. N. Falge, research engineer for the Guide Lamp Corporation, checks both the patterns of the light beams and their intensity, the latter being measured by means of a specially developed photronic output meter and registered in lumens on a micro-ammeter.

Motor-car headlights ready to be checked for pattern and intensity

With the car standing on four special flat steel plates to assure proper position and correct level, the lamp beams strike twin "aiming heads" 18 inches distant. Each "aiming head" carries three specially-ground meniscus lenses which collect the light from a given area of the headlamp and focus it in various patterns on a target card. The latter is provided with cross lines indicating the desired shape and locations of the beam patterns. The "aiming heads" may be raised or lowered by means of adjusting screws calibrated to change the level of the lamp beam in steps of one inch at 25 feet. With the head adjusted at the required level, the car headlamps then are aimed to bring their beams into proper relation with the target cross lines behind the lenses. Differences in battery voltages and candlepower rating are compensated for by a calibrated variable resistance control. All information revealed by the testing device is recorded on a special analysis chart for the convenience of the customer.



These three lenses are the heart of the headlight checking device

Hydro-Electric Steam Generator in Dairy Work

ELECTRICITY is used to make steam, instead of the customary process of steam being used to make electricity, in a new hydro-electric steam generator recently put into service in the Montreal milk and ice cream plant of J. J. Joubert, Limited. This is believed to be the first installation of its kind for large scale dairy work in Canada or the United States.

Four coal-fired steam boilers of 150 horsepower each are replaced by the new steam generator which is of the water resistance type. In such an installation, electrodes are submerged in water and heat is generated by the passage of current through the water between the electrodes, the water itself forming the resistance.

It is estimated that, at the present price of coal in Montreal, steam made in coal-fired boilers would cost about 46 cents per thousand pounds. During the first month of the new generator's operation, the steam made by electricity cost 32 cents per thousand pounds.

One of the unusual features of the installation is its ease of control. The flow of steam can be regulated by a control system which injects a small amount of salt into the boiler feed water to increase its conductivity. Various other control mechanisms are on the panel such as safety switches and low water alarm, as well as duplicate safety valves.

Three cast-iron electrodes about 10 inches in diameter are arranged in a triangular form within the boiler which is about 30 inches in diameter and 10 feet in height.

Vertical hydro-electric steam generator and its control instruments

The space occupied by the boiler is about 10 feet square and requires for dismantling a total height of 25 feet in order to raise the electrodes clear of the top of the boiler for any possible repairs or cleaning.

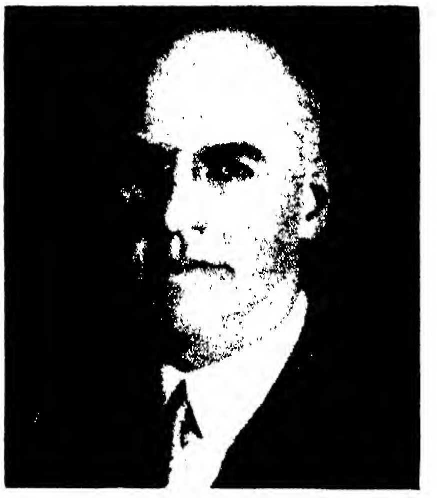
Without any water in the boiler no current flows but as soon as water is pumped into it and the bottom of the electrodes are covered, current starts to flow. The more the electrodes are submerged, the more steam is obtained from the boiler. In other words, the amount of steam is increased by pumping additional water into the boiler.

PROGRESS In This Age Of Science

As Told to SCIENTIFIC AMERICAN

By ALVAN MACAULEY

President, Packard Motor Car Company



THE field of research and invention and the high perfection that has been reached in mechanical processes have brought all manufactured products, automobiles as well as practically everything else, to a state of development today that goes far beyond that which would have been thought possible only a few years ago.

Among motor cars this is particularly true. Development and improvement of automobiles in just the last year or two exceeds that which had been accomplished in the previous five or six years, perhaps even the last ten years. Buyers of today are certainly obtaining new and almost undreamed of values for their dollars.

These values extend back all the way from the ultimate consumer to the raw materials. The manufacturer's dollar is buying more also, making it possible to pass further values along to the consumer.

We came to the realization of this when we started out to build a completely new plant for the manufacture of our new car. We were fortunate indeed in being able to do it at this time. The machinery manufacturing industry has gone far in development of new machinery. Otherwise perhaps such a car as our new one could not have been built to sell at anywhere near its price. If it were possible or economically feasible to scrap all the machinery in the automobile industry and replace it with completely new equipment all automobiles would be still further improved and could be manufactured at considerably less cost.

Of course this could not be done, any more than it would be possible to scrap all railroad passenger cars of today and replace them at once with light weight, air conditioned, high speed units representing the latest development in railroad travel. The savings in the country's railroad freight bill alone if ponderous freight cars could be advantageously replaced with those of light alloy steel construction would be almost incalculable.

However, benefits from all of these great developments and improvements which have come from an inventive people hard at work trying to pull themselves out of a record breaking depression will accrue to the country. Eventually these new things will replace the old. Machinery that can finish a cylinder block in half the time at half the cost and do the job far better will force out the old equipment, just as an old freight car cannot long stand against a new one which carries twice the load at one half the cost to move it. America of tomorrow is going to find good reason to be extremely grateful for American inventive genius of today.

While no one believes implicitly in the age-worn theory that a better mouse trap built in the woods will sell itself, there is a place always, even in the most crowded markets, for a new and superior product. That was our thought in building the new lower priced Packard car.

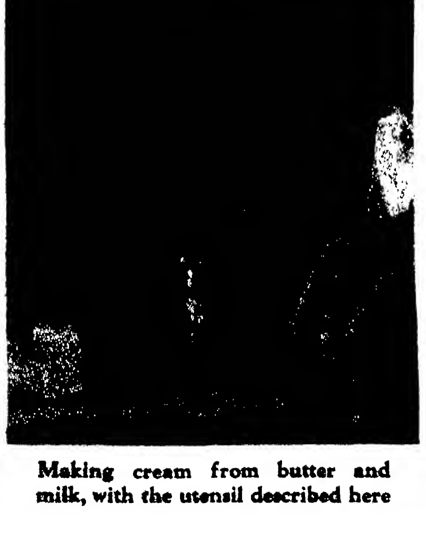
INSANITY'S INCREASE

COMPARED with 1910, the proportion of patients with diseased minds has risen from 173 to 225 per 100,000 population. This is a sad commentary on our rapid pace of living.

Real Cream Made at Home

HOME made cream, compounded from butter and milk, is available to every home now that a hand homogenizer, marketed by Club Aluminum Products Company, has been placed on sale through the nation's department stores. Heretofore, cream has been like Humpty-Dumpty—once it was separated into butter and milk it couldn't be "put together again." But the home homogenizer does just that. An ounce of unsalted butter and a half pint of milk are placed in the bowl of the gadget, the handle is jerked up and down a few times and presto!—fine, thick cream spurts from the nozzle, and at about half the price that the milk-man charges. Whipping cream, fully equal in whipping properties to the best grade of natural cream, can be compounded at one third the cost from the dairy.

Technically, the 12-ounce machine is well made. The parts are of bronze and aluminum, and no rubber gaskets or washers are needed. Inside the bowl is a small pump, with the piston attached to the lever. The mixture to be emulsified leaves the lower end of the pump through a small hole and is distributed along narrow, radial, horizontal grooves. In operation, the jets of liquid strike the vertical walls of the emulsifying chamber with sufficient force to disrupt fat globules, forming a permanent emulsion. The pump handle also operates a beater which agitates the untreated liquid in the reservoir.



Making cream from butter and milk, with the utensil described here

An early handicap for the machines was the need for using only salt-free butter, since cream from salt butter tastes definitely salty. The cream-maker is now sold with desalting equipment, however, obviating the need for special butter, and involving an extraction of the salt content with water. In domestic use, the butter is boiled with water, and then the mixture is poured into the bowl of the machine to settle for a minute or two. A valve permits removal of the lower layer of saline, leaving the butter sufficiently salt-free to furnish perfect cream.—*A. E. B.*

This Year's Motor Car

HERE, in summary, is what will be offered to the motor car buyer in 1935 and 1936. Cars will be even more streamlined than those of 1934, not merely because they offer advantages of fuel economy but because the buying public wants a "fast-looking" car.

Cars will develop still more power, partly because of improved engine design and mainly because gasoline is improving rapidly. The standard "gas" of today is the premium gas of five years ago and better than any gasoline sold 15 years ago.

Wider use will be made of the "overdrive," the use of a fourth speed shifting over either automatically or manually at about 50 miles an hour which slows down the engine speed to about three fourths of its maximum number of revolutions per second. With driving speeds on open intercity highways reaching speeds of 60 miles an hour the overdrive will have economy angles from the standpoint of fuel consumption.

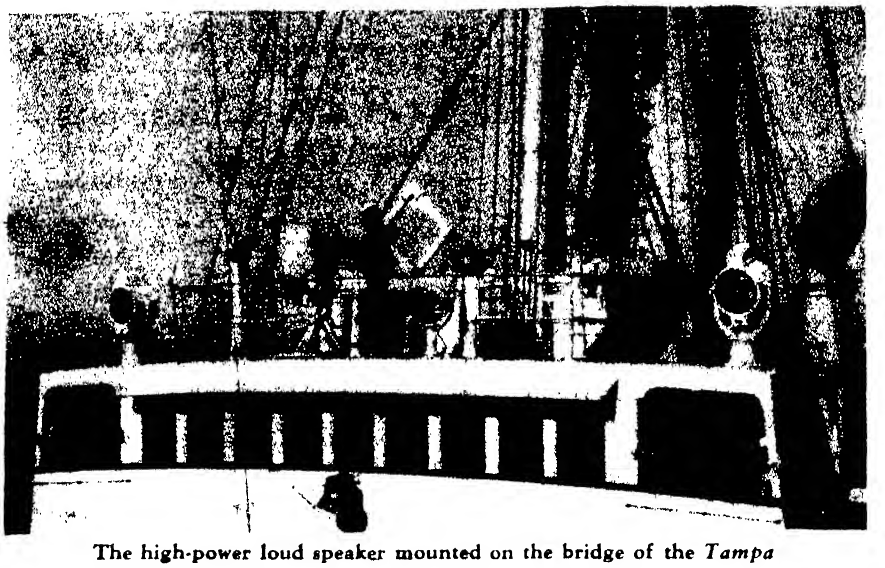
Independent spring suspension on the front wheels is now installed on about half the cars now being sold. Its principal value comes at speeds over 35 miles an hour and

as average car speeds go up it may gain in use.

Cars of the future will have larger generators to maintain the proper voltage in the battery. The growing use of automobile radios is, in part, responsible. There is also the demand that sufficient electricity be supplied at the higher driving speeds—when the charging rate is automatically decreased—to make the headlights shine as brightly at 50 and 60 miles an hour speeds as they do at 30 miles an hour now.

Finally brakes will be improved, not alone in plain stopping ability but in uniformity of action on all four wheels in all kinds of weather—hot or cold, wet or dry.

Such is the forecast of the future in automobiles made in the official journal of the Society of Automotive Engineers by Henry M. Crane, technical assistant to the President, General Motors Corporation.



The high-power loud speaker mounted on the bridge of the *Tampa*

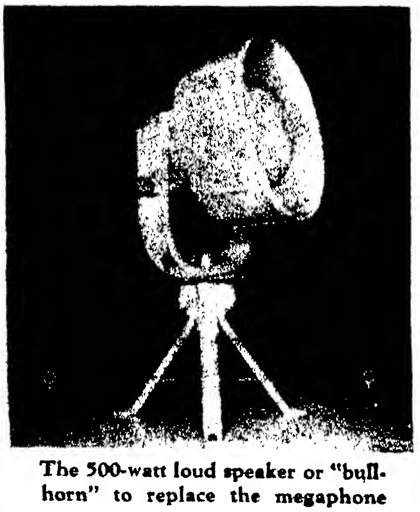
Stentor Outdone

WHEN the American yacht *Rainbow* defeated the English yacht *Endeavour* in the International Yacht Races off Newport, last September, a newly developed loud speaker, so powerful that it can magnify the human voice a million times, was in operation for the first time. It was used aboard the U. S. Coast Guard cutter *Tampa* to warn shipping off the course and to issue instructions to spectator craft.

While the *Tampa* used the new sound projecting device at less than its full power, it has been so designed that it can be made 500 times more powerful than the ordinary loud speaker. At full power it hurls sound into the air with the force of a 50-pound hammer blow. Over flat terrain, in still air, it can project intelligible speech at a distance of several miles.

The volume produced exceeds the classically loud sounds of nature. The voice can be made louder than a clap of thunder. Measured at the horn's mouth, the sound is about 1000 times louder than the roar at the foot of Niagara Falls. The new loud speaker not only carries over distances beyond reach of existing speakers but will penetrate a din which would drown out the most powerful equipment heretofore available.

Clarity is obtained in spite of the tremendous power because the design intentionally emphasizes those voice tones which contribute most to making speech intelligible, while filtering out the other frequencies. This enables the output of the new speaker to pierce through a tumult of other noise and reach ears which already may be receiving a virtually deafening burden of sound.



The 500-watt loud speaker or "bull-horn" to replace the megaphone

Use is foreseen for the new speaker in directing throngs of people either too vast, or in the presence of too much noise, for the ordinary loud speaker to be heard. Fire fighters within burning buildings, deafened by the crackle of flames, could be directed by the giant voice. A rescuing vessel at sea could bellow instructions to a distressed crew or to persons in life-boats. In place of the fog horn's simple warning, the loud speaker could give spoken directions.

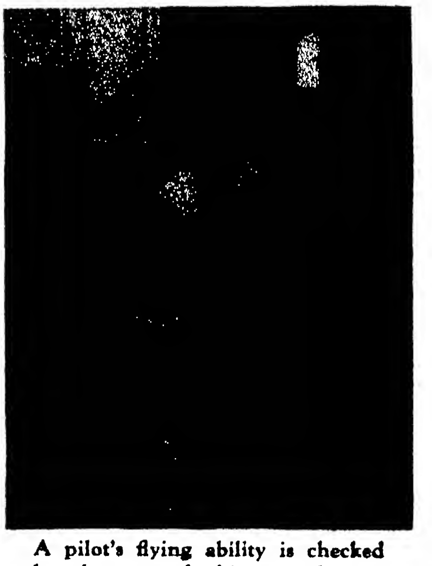
The new loud speaker is a recent development of scientists and engineers of the Bell Telephone Laboratories, in connection with their researches in the transmission and projection of sound. The horn is made of cast aluminum, and aboard the cutter *Tampa* is mounted on a swivel mast and can be pointed in any direction. Despite its tremendous power, the system is compact in design and simple to operate, being entirely controlled by a single push button.

Forecasting a Pilot's Ability

A VALUABLE aid in predicting whether or not a candidate for flight training is likely to qualify as a pilot has been designed by Dr. L. J. O'Rourke, Director of Research and Personnel of the United States Civil Service Commission. The apparatus, which is shown in the accompanying photograph, bears the imposing title of "complex co-ordinator."

The device has been given extensive trials at the Army Air School at Brooks Field, Texas, and shows a marked relation between those men who make low scores in the tests and those who fail in flight training.

In the test of the candidate the co-ordinator presents the candidate with conditions which are very similar to those confronting him in actual flight. The apparatus consists of an adjustable seat and a set of airplane controls mounted on a frame in correct relationship to the seat. In front of the controls is an upright panel upon which is mounted a buzzer and a series of red and green lights. The flashing of one light means that the flyer is meeting a certain kind of simulated flight condition, to which he must react instantly in his operation of the controls. Another light indicates another condition to which the pilot must react in a different way. If the buzzer sounds in the midst of constantly flashing lights, the pilot has to do a certain thing very quickly or else meet with a simulated disaster. The promptness of action time is recorded automatically in hundredths of a second by a six-pen chronoscope. Besides recording time, the chronoscope records the correctness of control operation. The problems which can be presented to the pilot are of a very wide variety; thus we may have rudder and stick co-ordination; the correction of a violent stall, and so on.



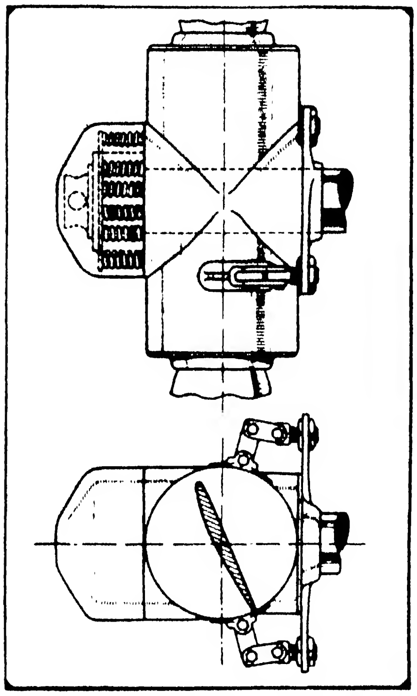
A pilot's flying ability is checked by the use of this co-ordinator

This instrument has now reached a high stage of development and will undoubtedly be useful for Army and Navy work. Of course, a man who does badly in the test may still make a good flyer, but the Army Air Corps which spends so much on training cadets will at least be able to minimize the risk of failure when taking on new students.—*A. K.*

An Automatic Variable Pitch Propeller

THERE is scarcely an important transport airplane in the world today which is not equipped with some form of variable

pitch propeller, either mechanically, hydraulically, or electrically operated. The improvement of performance to be gained by varying the pitch have long been beyond dispute. The sole disadvantage of a manually operated controllable pitch propeller is that it gives the pilot still another device to think of. Therefore, development work has been going on, particularly in the United States and in France, on automatic pitch control methods. The automatic variable pitch propeller produced by the Eclipse Aviation Corporation has gone through its



Drawings of the automatically variable pitch propeller described

tests successfully and has attracted much attention. To understand an automatic propeller of this type it is necessary to delve a little into aerodynamic principles.

The thrust of the propeller with the motor at full throttle is greatest when the airplane is stationary on the ground, held by chocks or a parking brake. It is then known as the "static thrust." To start off quickly on the get-away run it is advisable to have as large a "static thrust" as possible. Now, if the blade angle of the propeller is large, it resists the torque powerfully and the engine on the ground never turns up to its full revolutions per minute. On the ground, therefore, we want a device which will decrease the pitch, allowing the motor to speed up, and thus increase the static thrust.

On the climb following the take-off, the thrust diminishes but is improved if the blade angle is now made greater, because a larger blade angle or pitch coordinates better with a higher forward speed.

At cruising speed the thrust diminishes still further because the motor is now throttled down. But the air speed is greater than on the climb, and therefore the blade angle should be still further increased.

Summarizing: We need low pitch or blade angle with very high thrust on the ground; more pitch and somewhat less thrust in the climb; more pitch and again somewhat less thrust at cruising speed.

The problem for the inventor or designer of the automatic variable airscrew is, therefore, to make the thrust the controlling element. Thrust high, low pitch; thrust low, higher pitch or blade angle. The engineers of the Eclipse Aviation Corporation have realized this principle in a simple fashion. The design of the propeller is simple and requires only a few moving parts.

A linkage system which is anchored to the back plate acts as a fixed fulcrum. When

Variable pitch propeller installed on a standard radial plane engine

the thrust is very high the springs at the front of the propeller are compressed and the blades accordingly move forward. As the blade moves forward, the linkage straightens out, as can be seen from the sketch, and the blade setting diminishes accordingly. A typical arrangement is that shown in the diagram. At take-off and 1900 revolutions per minute, the blade angle is at 13 degrees to the plane of rotation. At cruising and 1600 revolutions per minute, the blade angle is at 23 degrees.

A little reflection over the diagram will make the working of the propeller perfectly clear to the reader who is interested in such simple mechanical devices. The advantage of the device in giving the propeller the right blade angle to suit every condition of flight without action by the pilot is obvious.—*A. K.*

War Weapons for Exploring the Air

THE Big Berthas of World War fame hold promise as valuable peacetime weapons for scientists interested in upper air exploration. These enormous guns, which nearly 20 years ago bombarded Paris with death-dealing projectiles, might just as readily bombard the mysterious upper regions of the atmosphere with devices for bringing back to earth samples of air and indications of how the winds blow.

Recording instruments carried aloft in kites, balloons, or airplanes have cleared up much of the mystery of the lower air—the so-called "troposphere"—and of the lower levels of the stratosphere, just above the troposphere. But no balloon scouting for meteorological material has yet risen higher than 22 miles. In the Paris bombardment, however, the Big Berthas hurled projectiles 24 miles in the air.

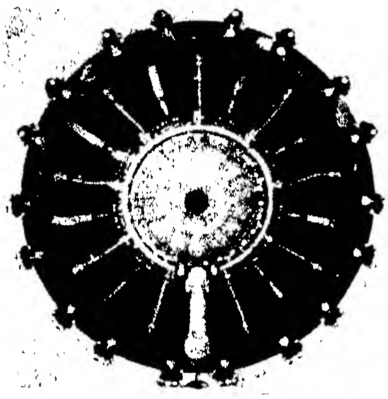
Observations in the troposphere show that air here moves in many ascending and descending currents, causing the formation and dissipation of clouds. Air movements in the stratosphere, on the other hand, are believed to be generally horizontal. As air mass movements are responsible for our weather and as the movements in the lower levels are affected by those at upper levels, definite information on what is happening at these heights would be of great value in weather forecasting.

A Radio Compass for Itinerant Pilots

A LONG-RANGE radio compass which enables itinerant pilots flying over oceans and unknown land to find their way

directly to any radio broadcasting station has been developed by the Westport Manufacturing Company. The first Westport automatic radio compass for civil use was built for a Lockheed Vega.

The radio compass consists of an indicating dial mounted in the cockpit, a conventional aircraft radio receiver, a compass converter unit located in any convenient place, a dynamotor, and a loop antenna mounted in the fuselage. The complete assembly including cables weighs less than 45 pounds, while the receiver and converter

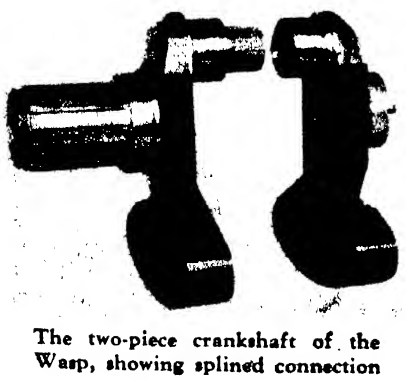


Front view of the new Wasp airplane engine described. *Right:* Back, showing some of the accessories

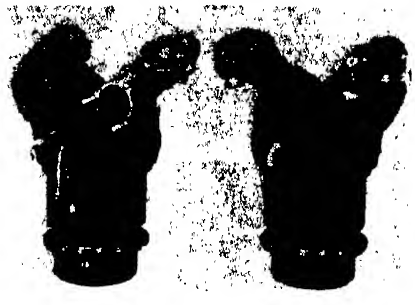
units measure only 12 by 7¾ by 11½ inches over-all. When within range, a pilot may tune in on a broadcast station by listening through the earphones in the customary manner. If the plane is headed directly toward a station, the indicator needle on the dial points to "zero." If the plane is off course ever so slightly, the needle points "right" or "left" as the case may be. In addition to enabling a pilot to fly directly to a radio station, the radio compass gives a navigator all the information he needs to locate his exact position over land or sea. To do this, he tunes in several different stations, determines their direction, and by a system of triangulation determines the location of the plane.—*A. K.*

A Wasp with Automatic Lubrication

A NEW Wasp airplane engine has been announced by the Pratt and Whitney Aircraft Company. The new engine is more rugged, develops greater power, and requires less servicing than any of its predecessors, which have made so enviable a reputation for themselves in military, naval, and transport aviation. Though it develops 550 horse-

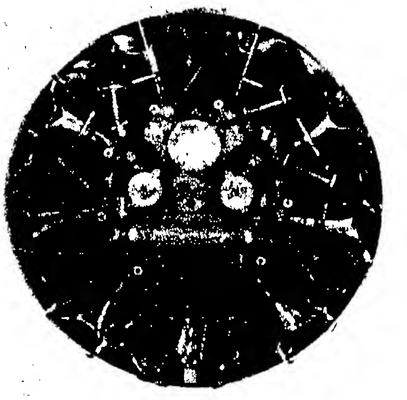


The two-piece crankshaft of the Wasp, showing splined connection



Back and front of Wasp cylinders

power in its geared down drive embodiment, it is basically and fundamentally the same engine as that which made its first appearance eight years ago. Just as the first Wasp engine, the new model H has a displacement of 1344 cubic inches, a bore of 5¾ inches, and a stroke of the same amount. The increase in power has come step by step — by higher compression ratios, greater refinement in design, and systematic improvement. The power is developed at the moderate speed of 2200 revolutions per minute. The specific output per cubic inch of displacement is now four tenths of a horsepower, while a quarter of a horsepower per cubic inch was considered fine practice only a few years ago.



The Wasp H embodies many striking improvements, but the outstanding feature of the new engine lies in the automatic lubrication of the valves and valve actuating mechanisms by means of the standard engine oil supply system. This will eliminate the manual labor, grease guns, and the stocks of grease now essential. The cost of engine maintenance and transport operation will be reduced thereby, and the reliability of operation will be increased. American airline operators will bless this one new development many times.

Valve tappets, ball ends of push rods, rocker bearings, balls of adjustment screws and valves are now all lubricated by pressure, eliminating the use of rocker box grease and periodic manual servicing. Scavenged oil in the upper cylinders drains down through the pushrod covers into the sump, while from the lower cylinders it passes through an outside oil manifold attached to the cylinder heads and is scavenged by an additional suction stage on the oil pump. Rocker boxes have improved covers which are made oil tight by the use of gaskets and which are secured by means of studs and nuts.

Two of the photographs show the front and rear view of the engine, and give a splendid idea of its "cleanness" and mechanical finish.

With increased power, there must go increased strength. Thus the single-throw two-piece crankshaft, split in the center of the pin, has been suitably reinforced and its diameter has been increased. The rear section of the shaft telescopes into the front section and is held in position by splines. Formerly only 16 splines were used but there are now 31, adding materially to the ruggedness of a part which has to take up great torsional stress.

The more power developed by an engine,

Power section of the Wasp engine

the more cooling is required. Therefore, more and deeper cooling fins are provided. The exhaust ports now have shrunk-in stainless steel liners (stainless steel to resist corrosion) for a slip joint with the exhaust pipe, thus eliminating the flange used in previous models.

Another very interesting feature of the engine lies in the baffles. It is easy enough to cool the front of the cylinder on which the air impinges directly, but not so easy to cool the rear. The baffles, which are sheet aluminum surfaces, carefully formed, guide the air tightly around the cylinders and to the back, so that no part of the cylinder is left uncooled. These baffles are so constructed and affixed on the model H that any cylinder or group of cylinders may be re-

The heads of the pistons in the new Wasp engine are flat, but recesses have to be provided for the valves

moved without removing the carefully placed baffles. This is a feature which will appeal immediately to a practical mechanic.

A noteworthy point in the design of the power section of the engine is the cam system. The H Wasp cam revolves on a bronze bearing of large surface which is mounted on a shelf housed by the front section of the main crankcase. It is driven by a reduc-

tion gear with a bearing on each side assuring correct alignment. Valve tappets are mounted in guides located in the front section of the main crankcase directly over the cam track. Through such an arrangement a more direct load on the rockers is provided because of the decreased angle of the push rods in respect to the rockers. Thus greater rigidity is secured.

The pistons are machined from aluminum alloy, provide a compression ratio of 6 to 1, and have flat heads with recesses for both intake and exhaust valves. Piston pin bosses have been considerably strengthened and the under side of the piston head is ribbed for strength. Each piston has four compression and one scraper ring.

Space will not permit us to detail with many other interesting features such as supercharger clutch, reduction gear, temperature control, and so on.—*A. K.*

PAPER DOTS

PAPER perforations, dropping from the holes in U. S. stamps, totaled 35 tons during the last fiscal year, during which 12,000,000,000 United States stamps were made.

A Two-In-One Plane

THE great difficulty in transatlantic flying is in the building of a seaplane which will have not only the required range, but also carry sufficient mail or payload beyond the huge amount of gasoline which is required for a non-stop flight.

Short Brothers are now constructing in England, under the auspices of the Air Ministry, a two-in-one plane which may meet the difficulty.

The seaplane, which is to be used for the non-stop transatlantic operation, will be a comparatively small machine, with a tremendously heavy loading in pounds per square foot of wing area. The heavy loading will not decrease the high speed so very much, and it will enable both sufficient fuel and payload to be carried. But with this heavy loading the craft may be unable to get off the water at all, or to climb to a reasonable altitude!

Major R. H. Mayo has suggested that the difficulty be met by using a large "carrier" flying boat which will take up the smaller machine to the necessary altitude where it can operate on its own.

The heavily loaded small machine, and the lightly loaded big machine will be locked together by a patented device, and will take off as a unit, using their combined horsepower. As the big machine will be lightly loaded, as for a short flight only, there will be sufficient excess power for rapid take-off and climb.

When the appropriate altitude is reached, the pilot of the smaller craft will release a locking lever, the mail plane will sail away and the "carrier" will return to its base.

No details are available as to the mechanism, but this is of an obvious character and offers no particular difficulties.

The reader may ask why this device is considered superior to the catapult with which a heavily overloaded plane can be quickly launched into the air. The reasons are twofold. With a very heavily loaded craft, the speed of launching has to be

The *TC-13*, with its ground crew

high; the accelerating process will have to be very violent, putting heavy stresses on the machine and not making the flier any too comfortable. Another difficulty is that while the plane may come off the catapult it will still be flying with but very little excess power and a dangerous forced landing might be feared at times. In the new system the "catapult" will really launch the machine very gently and at a reasonable height above the water. So if the release is not successful, or any other difficulty arises, the pilot will have plenty of time to dump the fuel and make a subsequent forced landing without undue hazard.

British authorities are also agreed that this process will be preferable to refueling in the air, or to alighting at a mid-ocean base of an artificial character.—*A. K.*

Army Airship "TC-13"

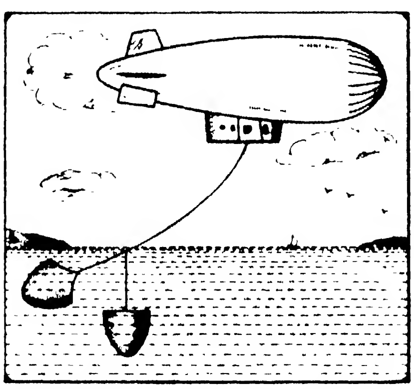
WHILE no rigid airships are at present under construction in the United States, the Army Air Corps is actively developing the smaller non-rigid type formerly termed the "blimp." The latest example is the *TC-13*, which is perhaps the largest non-rigid ever built in the United States. The *TC-13* has an over-all length of 243 feet, a diameter of 54 feet, and a height, including the airship car carried underneath, of 69 feet. The helium gas capacity is 360,000 cubic feet. The gross lift is 22,300 pounds and the fuel capacity, 900 to 1300 gallons. The *TC-13* has a cruising range of 1000 miles at 65 miles per hour and can remain in the air about 100 hours when maintaining a slow speed of only 25 miles per hour. It can pick up fuel while in flight and is equipped with a radio set of 3000 miles' range. The tanks for fuel, water, and storage are overhead. Instead of the four usual control surfaces, it has five. The equipment includes a sub-cloud car for observation purposes, which can be lowered by a single cable to about 1000 feet below the ship.

A very interesting feature of the new design is a sea anchorage (illustrated in the sketch), principal features of which have been definitely established during 75 hours of experimentation.

A winch is provided in the car, which carries six to eight hundred feet of anchor cable, on the extreme end of which is fastened a drag cone of large diameter. Approximately 80 feet from the drag cone is fastened a weight cone which holds 1000 pounds of water. The weight cone stabilizes the variation in lift resulting from aerodynamic disturbances or changes in gas temperature and also serves the useful purpose of keeping the drag cone submerged at all times, so that the drag load is constant and wave shock is eliminated.

Adjustable rigging at the ship permits the point of application of the anchor cable to be varied fore and aft so that the kiting or dynamic lift effect on the ship may be varied to suit the wind speed.

Weighing—pulling up—the anchor is normally accomplished by releasing a trip weight which runs down the anchor cable



The drag and weight cones used for anchoring the *TC-13* when at sea

and inverts the weight cone, spilling its load. The drag cone is then pulled out of the water under power, its water being spilled through a hole in its bottom. Emergency release is accomplished by tripping all cables and cones free of the ship.

While riding at anchor the ship may be "flown" or piloted as when under power and its drift is cut down to approximately 25 percent of the wind speed. This feature is believed to be a decided advantage in case of power plant trouble or fuel shortage during a high wind period. Otherwise the airship might be driven by the wind for long and dangerous distances.

This new method of sea anchorage is certain to be of great utility in airship operation.—*A. K.*

Aerial Study of Pollen in Atmosphere

ONE of the most curious projects of analytical chemistry has been inaugurated in Philadelphia, where a fleet of airplanes is sampling the atmosphere for miles above and around the city in order to determine the exact amount of pollen in the air. The survey is being made by scientists of the Philadelphia College of Pharmacy and Science, as an attack on the problem of relieving victims of hay fever, a malady caused, or at least aggravated, by the presence of pollen in the atmosphere.

The survey is intended to measure accurately the density, nature, and distribution of air-borne pollen in the upper atmosphere and will be carried on over the Philadelphia metropolitan area, extending in many directions as far as 40 miles from the city center and also along the New Jersey coast in and around Atlantic City and seaward for 20 miles. Daily flights are scheduled throughout the hay fever season for the next four years.

The apparatus for carrying on the work was developed in the engineering laboratories of the college under the direction of Frank N. Moerk, assistant professor of manufacturing chemistry. The airplanes with which the survey is being made were made available by Richard Mark, a hay fever sufferer.—*A. E. B.*

Keeping Engines at the Same Speed

TACHOMETERS for aircraft engines have undergone considerable modification since early days. At first the tachometers were mounted directly at the back of the engine and were gear driven. Then, as the pilot's cockpit moved further from the engine, flexible shafting was employed for the same purpose. Now, when two or more engines may be disposed along the wing at distances of 20 feet or more from the dashboard, it is clear that flexible shafting or mechanical gearing tends to become impracticable.

Since the practical medium for speed measurement and transmission appears to be electrical in character, the Pioneer Instrument Company has announced a new and simple electrical tachometer. A generator, driven by the engine, is a simple two-phase, three-wire machine, based on well-known principles. This is mounted in the nacelle, or wherever the engine may be, and the current which it generates is led to an

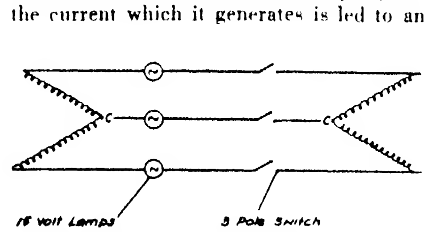
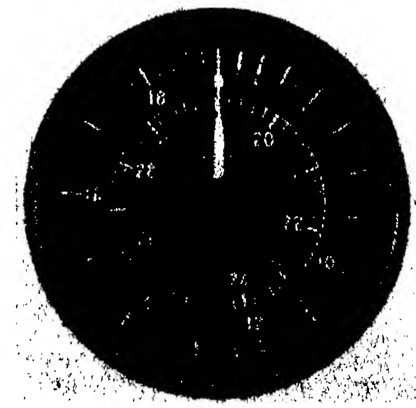


Diagram of tachometer generators (above), and the indicator (below)



induction type indicating instrument. The advantage of the induction type indicator is that the alternating current is led around stationary magnets, and that the sole moving element is a thin metal disk (restrained by a spring), the displacement of which is exactly proportional to the revolutions per minute of the engine.

With the use of tachometers of the electric type, there is another advantage which is illustrated by the simple diagram. The tachometer generators of the engines on each side are connected, as shown in the diagram, to three lamps. When the pilot has succeeded in bringing the engines as nearly as possible to the same speed, he closes the three-pole switch. If the generators of both engines are running at exactly the same speed their voltages meet and nullify one another, and none of the lights will burn. Should the generator speeds vary by as much as one revolution per minute, the lamps start flickering, and the rate of flickering will increase with the difference in speed between the engines.

The advantages of such an electrical check-up to the pilot of a multi-engine airplane are obvious. *A. K.*

SINO-JAPANESE

IT would appear that the Japanese are great admirers of Chinese culture. Compulsory study of Chinese by the Japanese Empire, with a population of 94,000,000, totals half a billion years, since each individual must study Chinese for at least six years.

Aluminum and Cancer

IN view of articles in the daily press, ascribing to aluminum, lead, and other substances a cancer-producing action, a recently published experimental study denying such harmful effects is of much interest.

In a recent issue of the *Annales de l'Institut Pasteur*, Bertrand and Serbescu report two series of experiments on rabbits. In both series, coal tar was applied at regular intervals to the ears of rabbits in order to produce a cancer. In series A a visible cancer resulted in 78.3 percent of rabbits living more than 40 days. No aluminum was given in this series. In series B an artificial ear cancer resulted in 50 percent of the animals living over 40 days. In this series a solution of aluminum sulfate was placed directly in the stomach.

In neither series did the necropsies reveal any visible lesion of the stomach or intestine. The authors conclude that the rôle of aluminum or its salts in the production of cancer has been greatly exaggerated. Fear of the ingestion of the minute amounts of aluminum from the use of utensils made from this metal as well as from foods or baking powders in which alum salts are used is not justified by laboratory research.

—*Journal of the American Medical Association.*

Dry-Ice as Rain-Maker

ACCORDING to Consul Sydney B. Redecker, Frankfort-on-Main, Germany, in a report made public by the Chemical Division of the Department of Commerce, experiments are soon to be conducted in

Wurttemberg designed to produce rain artificially. The experiments will be under the auspices of the Society for Dry Ice Research, recently established in southern Germany, and the plan is to scatter pulverized dry ice from airplanes above the clouds. It is alleged that copious rainfall was produced over the Zuyder Zee by this method a year ago, when two tons of dry ice were discharged over clouds.—*A. E. B.*

"Age" and Whiskey

THE repeal of the 18th Amendment descended upon a country in which credulity with respect to liquor consumed was unbounded. If "Joe" said it was good, it must be good, for Joe bought enough whiskey to know. Besides, Joe had said it was "Old Stuff," and the word "old" carried a great significance during a period that supposedly saw no manufacture of whiskey. Age came to mean more than the mere passing of time. It was a symbol of genuineness. Although aging certainly plays an important part in the production of fine whiskey, it is not so all-important as

Weighing-in barrels of whiskey for federal tax determination purposes

many would make it seem when measured only in terms of days, weeks, months, and years.

Whiskey may be of several different varieties, depending upon the mixture of grains used in its manufacture. Each of these varieties has its own individual flavor, the excellence of which hinges upon the quality of grain used and the manner of its conversion into alcohol.

All of the preliminary treatment of the grain leading up to the actual fermentation is in preparation for fermentation, the result of which is alcohol and acid. Naturally, these ingredients alone do not compose the Beer, or fermented mash. There are higher alcohols, such as fusel oils, aldehydes, and water. [See also "What is Whiskey?" page 70, August, 1934, SCIENTIFIC AMERICAN.] There is also a certain mineral content. The Beer is now distilled, but this process is not carried to the extreme, for if all of the impurities were lost, the result would be pure alcohol. Certain impurities, modified during the aging period, are necessary to give whiskey its color, flavor, and aroma. The higher alcohols, acids, and aldehydes (called congeners) have a very strong, and at this

In the background is the equipment for the heat treatment of whiskey

stage disagreeable, odor and taste. It is with these elements we have now to deal, for at this point the "aging" of the whiskey begins.

It was found in the early days of distilled beverages that the presence of char in storage barrels not only reduced the loss due to excessive absorption but also contributed a mineral content and certain resinous nature to the whiskey which highly improved both its color and flavor. The degree to which this color and flavor existed seemed to depend upon the length of time the whiskey had been permitted to stand in the barrel.

The next discovery was that whiskey made in warm climates aged better and faster than whiskey made in cold climates. It was found that the summer months were better than the winter months in results obtained from stored whiskies. Whiskey came to be spoken of as so many "summers old." The next natural step was the introduction of perpetual summer into the distiller's rack-warehouse. The heated rack-warehouse produced a finer aged product in a shorter time. Thus the distiller could sooner recover his investment in taxes made at the time of manufacture.

It was not long before a distiller decided to experiment with chemical changes in whiskey by the application of heat. A steam coil was introduced into the barrel and live steam passed through it, heating the whiskey. Under such favorable heat conditions the acids combined rapidly with the higher alcohols, and the char imparted its benefits freely, absorbing harmful ingredients and contributing desirable minerals and oils. "Aged" whiskey was made in a short period of time, and contained less heavy oil and aldehydes.

But, like any other innovation, the heating process was fraught with dangers and difficulties. No one seemed to be able to control the steam coil and obtain an even temperature so that whiskies of consistent quality could be manufactured. There was burning and scorching. There was leakage and reduction in proof of the contents. The 18th Amendment found things in this state—and legal experimentation stopped.

The Dry Era was coincident with great developments in modern science. Heat engineering had progressed equally with its fellows. With the advent of repeal, it became possible for the distiller to adopt a controlled heating method for aging his whiskies. Modern distillers have spent great effort, time, and money on the further development of these processes. Controlled heat has become a major factor in the aging of whiskey, giving a product which compares favorably in palatability and congeneric content with whiskey aged for four years or more in the barrel.—*By James D. Webb.*

JUST A WORD

YES, sodiumditolyldisazobetanaphthylaminesixsulphonicbetanaphthylaminethreesixdisulphonate is the chemical name for a Congo red dye.

Tires Made Puncture Proof

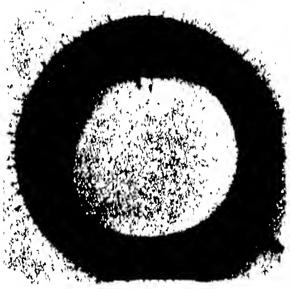
THE modern motorcar is to a large extent safeguarded against accidents by the perfection of its design and manufacture. There are two exceptions. Punctures and blowouts, despite many attempts to produce a blowout-proof tire or tube, are still the cause of a large percentage of fatal accidents each year. Such accidents may be prevented, according to reliable information reaching us from Germany, by the use of a new product patented in that country.

Blowouts may be due to expansion of air

Chemical analysis and control of ingredients are important in whiskey

in the tube caused by excessive speeding over heated roads or by traveling over stones or bumps with insufficient air in the tires. Skidding contributes its share to fatal accidents resulting from blowouts.

Oddly enough this new invention does not pertain to tires or tubes but to a substance which the car owner inserts in the tube through the valve aperture. This compound is composed exclusively of natural products which, according to the sworn



Nails in a puncture-proof tube fail to let out the air

statements of commercial chemists, are by no means deleterious to the rubber. Floating freely within the tube it is thrown by centrifugal force against the periphery so that should the tire and tube be punctured or ripped, this material is immediately thrown by pressure of the air into the opening. The result is that the puncture is immediately sealed by the substance. In case of a blowout, the substance prevents the rapid escape of the air and the car can be brought to a stop safely.

It is stated that this substance is not a conductor of heat and will not therefore transmit to the air the road heat absorbed by the tire tread. The weight and bulk of this substance are small. It cannot choke up valves, undergoes no changes during the whole life of the tire, and is perfectly harmless to clothes and hands. Its advantages, as can readily be seen, are numerous, one of the most important being that it gives a sense of security that enhances the pleasure of safe, carefree driving regardless of speed. The purchase price of this compound, incidentally, adds only 25 to 35 percent to the average price of a tube. It is at present being distributed widely in Germany and other countries.

Short Wireless Waves in the Treatment of Disease

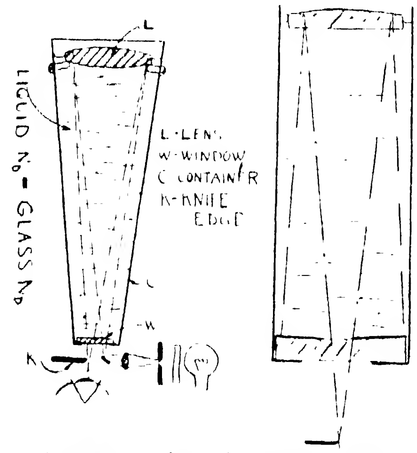
THE treatment of chronic inflammation, especially of deep-seated structures, by short waves, similar to those used in broadcasting, is already popular on the continent of Europe. These waves are usually only from 6 to 30 meters long and are generated by thermionic valves or by a spark gap machine. They can be passed into a patient without any contact between him and the source of the current. While the surface of the body remains comparatively cool, heat is generated in the tissues within. Dr. W. J. Turrell, medical officer to the electrotherapy department at the Radcliffe Infirmary, Oxford, tested the effects of these short waves on white of egg and on pieces of bullock's liver. He found that they differ from those used in diathermy, in which the electrodes are in contact with the patient's body, in the more violent oscillations of an

(*Please turn to page* 102)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

MANY of the advances in practical optics and telescope making have been made by amateurs. Such an advance is a very much needed test for convex optical surfaces, devised by J. H. King of Amityville, New York. At our request, Mr. King has prepared a description of his test,



Apparatus for the King Test. ***Left:*** **Figure 1.** ***Right:*** **Figure 2**

which is reproduced below, and a world of refractor and Cassegrain reflector makers will doubtless vote him sincere thanks for discovering it. Mr. King writes:

"CONCERNING the polishing of convex spherical surfaces, Ellison states in 'Amateur Telescope Making,' second and third editions, page 118, second paragraph, 'No question of their figure can arise at this stage of the proceedings, as it is impossible to test it.' Professional makers sometimes test convex spherical surfaces by interference methods, referring the convex to a standard concave. This method is hardly practical unless a number of similar convex lenses are to be made.

"Judging from the number of times the desire has been expressed for a test for convex lenses which would be as simple as that for concave mirrors, it would seem that such a test, if available, would be very useful. Therefore, the writer proposes a test for convex spherical surfaces requiring no auxiliary optical surface, and one which is simple and as rigorous as the mirror test at center of curvature.

"If, for the sake of illustration, we imagine a spherical surface consisting of only a skin of silver of practically no thickness, which would at the same time remain optically true without support on either side, one side would be a convex mirror and the other a concave of the same radius. Then, in order to test the convex mirror, one would merely have to go around to the other side and test the concave at the center of curvature.

"However, practical optical surfaces are generally formed on glass but if, as in the case of convex spherical surfaces on lenses, we could eliminate the lens optically and leave the surface to be tested, we could again go around back of the convex and test it as a concave mirror at the center of curvature and that test would be the equivalent of a test of the convex surface.

"To do this, we make use of a simple principle employed for many years in inspecting optical glass, but to the writer's knowledge never applied in this manner. In examining optical glass for striae and general uniformity of index, when it is in crude broken chunks, it is placed in a large container having glass windows at either end. Liquid is introduced having the same refractive index as the glass and then, if the glass is homogeneous, one is able to look clear through the liquid and the chunk of optical glass, and the rays will suffer no deviation. In other words, we have optically eliminated the glass. Bell's 'The Telescope', page 61, gives an account of this method of inspecting optical glass.

"Figure 1 shows a sectional view of the set-up which allows us to test a convex as a concave by introducing a fluid equal in refractive index to that of the glass. The fluid optically eliminates the lens. Since the upper convex surface faces air, the light proceeding from the pinhole suffers a partial reflection and some of it returns to focus again adjacent to the pinhole and the test becomes merely that for a spherical mirror at center of curvature. The test is rigorous because it is conducted to all practical purposes entirely within the liquid medium, and the small amount of air between the eye and the window is too close to focus to be detrimental. Several solutions have come to the writer's attention as having about the refractive index of crown glass when near room temperature. Toluene [obtainable from dealers in chemicals; for example, Eimer and Amend, Third Avenue and 18 Street, New York City.—*Ed.*] seems to be the best commercially obtainable liquid, since it is homogeneous, and though inflammable does not have a low vaporization temperature. A very strong word of caution should be urged against the use of benzene or any other inflammable liquid which vaporizes at room temperature. The worst explosion due to chemical silvering would be very mild indeed compared with that due to a gallon of benzene properly vaporized and ignited in a closed cellar.

"Below is given a list of various liquids and their refractive indices for the sodium line at given temperatures. However, the refractive index usually does not vary widely with a slight change in temperature.

Aqueous Solutions (Sugar and Water)

Sugar—Refractive Index at 20° C.
1.5001 at 16 percent water
1.5033 at 15 percent "
1.4951 at 18 percent "

Non-Aqueous Solutions

Carbon tetrachloride 1.460 at 25° C.
Benzene 1.501 at 30° C. (Dangerous)
Aniline 1.586 at 20° C.
Glycerine (Glycerole) 1.474 at 25° C.
Toluene 1.495 at 20° C.
Carbon tet. 40 percent, Ethylene bromide 60 percent, 1.4989 at 25° C.

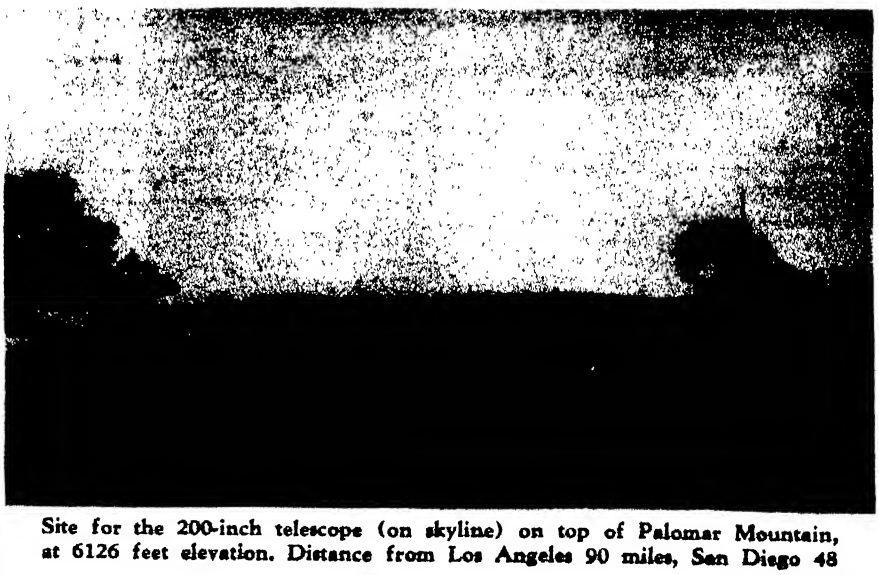
Aqueous Salts

Pyradine 85 percent, H_2O 15 percent, 1.4960 at 15° C.
NaCl 20, KCl at 80 percent, 1.500, 18° C.

"Some may raise the objection that the dispersion of the liquids may not be equal to that of the crown glass. Of course, testing in sodium light would remove this objection completely, but the writer believes that testing with white light is about all that is necessary and the refractive index does not have to be exactly that of the crown. This has also been borne out by experiment.

"As a matter of convenience, a small prism may be used in place of the window, and the testing funnel mounted on a wall. This allows the observer to assume a comfortable posture looking horizontally instead of lying on his back as in Figure 1.

"This principle is also applicable to testing a convex hyperboloidal surface by using a small spherical mirror of scarcely larger dimensions than the convex hyperboloid. Figure 2 shows the set-up. The spherical



Site for the 200-inch telescope (on skyline) on top of Palomar Mountain, at 6126 feet elevation. Distance from Los Angeles 90 miles, San Diego 48

mirror should be silvered and lacquered and the silver removed in the center, leaving a small transparent hole. Using this method, it is not necessary to construct a large optical flat or a large spherical mirror when building a compound telescope of the Cassegrain type. However, it would be well to construct the small secondary hyperboloid of optical crown in order to insure freedom from striae."

THE test which Mr. King describes above has also been tried, previous to this publication, by J. H. White of Cranford, New Jersey, in making a 3-inch objective lens and later a 4½-inch. Mr. White states that he finds it thoroughly practical. Besides the test described above (should it be called the King Test?), Mr. King has contributed another important advance to the telescope making art, having found a relatively simple way to render the Ronchi test quantitative without the use of mathematics, that is, by direct reading with apparatus. A description of this method will be found in the *Journal of the Optical Society of America* (Prince and Lemon Streets, Lancaster, Pennsylvania) for September, 1934, pages 250-252, and will be extracted here, provided the amount of response appears to justify doing so.

AT our suggestion Leo J. Scanlon of Pittsburgh has kindly written down some of the hints he has accumulated while learning to work glass with metal tools, and here they are:

"Glass or Pyrex mirrors can be ground on iron tools if the tools are first machined to proper radius of curvature. The tools should be cast, either in iron or brass, and machined to curve. Do not use steel plate. Lead is not so desirable as iron or brass.

"Iron tools may be rotated at a fairly high rate of speed—somewhere under 300 r.p.m., and the mirror may be rotated at the same speed on top, but I would not advise rotating anything larger than a 6-inch at this speed, while 50 or 60 r.p.m. is enough for a 10-inch. There is otherwise too much danger of breakage, if the mirror should stick to the lap and be whirled off.

"It is impossible to polish a lap on pitch at any of the above speeds, but flattened *H.C.F.* directly attached to the iron tool polishes very rapidly and very well. [Some professionals are now using this method.—*Ed.*] The mirror may be finished by hand, on pitch.

"The mirror may be whirled at the same speed as the iron tool; it may be held in the hands and slowly rotated first on one side of center and then the other while the tool revolved; or it may be ground as usual, but on an iron tool. Any of these methods will produce good results and they have all been tried here, some of them on mirrors up to 12½ inches in diameter."

Mr. Scanlon did not mention that, while it is easy to make the concave metal tool on the lathe, the convex tool is not nearly so easy, as it cannot be made on a radius basis; also that *H.C.F.* may be attached to metal by warming the metal.

THE Amateur Telescope Makers of New York City, Lew Lojas, acting secretary, 1510 White Plains Road, Bronx, New York City, is the latest organization of amateurs. Poor old tail-ender New York has a telescope makers' club at last!

THE SCIENTIFIC AMERICAN DIGEST

(Continued from page 99)

electromagnetic nature set up in the treated tissues. He obtained the best results in the treatment of parts connected with or closely underlying bony structures and in inflammatory conditions closely beneath the surface. Pain unrelieved by other methods yielded to this method. A great difficulty is the cost of the apparatus, as the power required to produce these short waves is much greater than for longer ones.—*Journal of the American Medical Association.*

Unique Multi-Unit Heating Plant

THE unique multi-unit central heating plant, consisting of 120 of the now familiar General Electric domestic oil furnaces all arranged to operate automatically in a single battery, which has been installed at Mount Holyoke College, South Hadley, Massachusetts, is now in regular service.

The new central plant comprises the major portion of a total of 172 of these furnaces installed at Mount Holyoke in providing a complete new heating equipment for the college. Fifty-three buildings now have the benefit of fully automatic heating. Of these 53 buildings, 24 of the largest and most centrally located structures on the campus are heated from the central plant. The rest of the buildings are at more remote locations around the edge of the campus and are equipped with single furnaces or with furnaces in small groups, the largest of which numbers 10 units.

When the problem arose of replacing the heating plant which had served the college for nearly 40 years, college authorities found themselves faced by an additional and corollary problem—the problem presented by far-reaching plans which had been drawn up for progressive landscaping of the campus. The old boiler plant, with its tall ugly smokestack, occupied a prominent location in one of the prettiest places on the campus. Obviously, a new heating plant of conventional design could offer no particular solution to the landscaping problem unless it could be located out of sight beyond the campus limits—an expedient which would have involved the construction of extensive additions to the existing underground steam distribution system.

The proposal which resulted in the construction of the plant just put into service offered an immediate and economical solution to the landscaping problem. Furthermore, although somewhat radical and perhaps startling at first glance, this new plant is based on sound engineering principles and embodies many unique advantages other than esthetic adaptability.

Although about 70 percent of the total college heating load is on the central system, this system is relatively so compact that transmission losses are gratifyingly small. Functionally, the entire system can be considered as consisting of two separate and distinct parts—steam generation and steam distribution. Each has its own physical equipment and automatic control, interrelated only by steam demand.

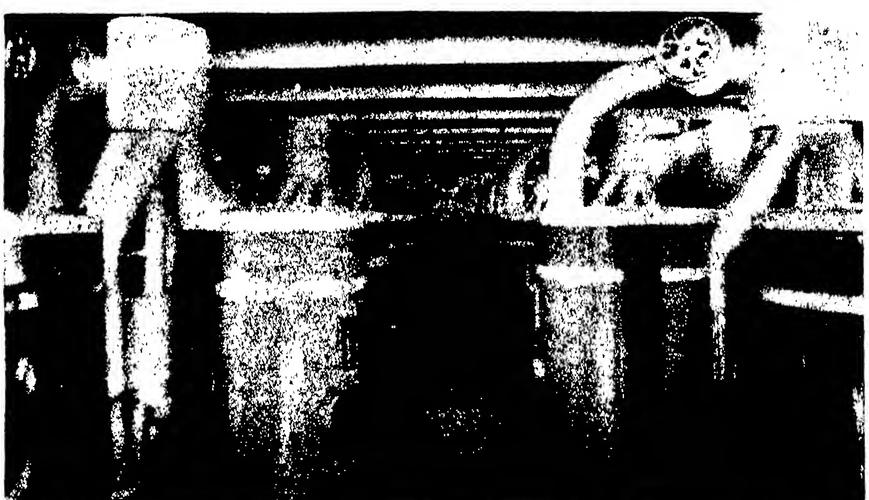
THEY STING AND LIVE

BEES, contrary to the general impression, do not always die after having used their stinger. This statement is made by Dr. J. G. Myers of the Imperial College of Tropical Agriculture, Trinidad, who has made tests to prove it.

Discovery of Heavy Hydrogen Wins Nobel Prize

FOR his discovery of the hydrogen isotope, deuterium, the basis of "heavy water" previously described in these columns, Dr. Harold C. Urey, Professor of Chemistry at Columbia University, has received the highest honor that can come to an American chemist—the 1934 Nobel Prize in Chemistry. The discovery of deuterium is regarded as one of the most important discoveries of modern science.

Dr. Urey, through mathematical consideration of the several theories involved, made the prediction that the hydrogen isotope H^2 must exist. Then began an intensive search which confirmed his prediction. While the significance of the discovery was scarcely realized at the time, it was soon recognized that the importance of the isotope might be greater than that of many of the elements. It became the starting point for research of



A battery of oil burners in a central heating plant

New type of transportation unit, using electric drive

a new kind in many laboratories. Indeed, there is hardly a chemical or physical problem which may not be affected eventually in some way by this isotope of hydrogen. The biologists are hopeful that heavy water may have great significance in many of their own problems, as, for example, the study of cancer. They have found that yeast cells and cancer cells share the property of multiplying or growing much more rapidly in ordinary water than in heavy water, and this fact may prove significant in future research.

Dr. Urey was born in Walkerton, Indiana, April 29, 1893. In 1917 he was graduated from the University of Montana with the degree of bachelor of science in zoology, and was an instructor there from 1919 to 1921. Two years later he received the Ph.D. degree in chemistry from the University of California. He was the American-Scandinavian fellow in Denmark during 1923-24, studying under Niels Bohr at Copenhagen. Dr. Urey was an associate in chemistry at Johns Hopkins from 1924 to 1929 and has been connected with Columbia University since 1929, being promoted to a full professorship in the spring of 1934. Now, having scarcely entered the forties, Dr. Urey becomes one of the three American chemists to whom the Nobel Prize has been awarded. The prize includes 40,000 dollars cash, which Dr. Urey says he will devote to further research.—*A. E. B.*

New Transportation Unit

AN unusual body design and independently driven wheels are features of a new type of transportation unit in which electric transmission is used. The engine is mounted longitudinally back of the rear axle and is connected direct to the electric generator by means of a rubber disk coupling. While primarily designed for rail coach, bus, truck, and highway maintenance use, with slight changes it can be furnished for any kind of service desired including portable electric power use and operation of machines constructed for special types of service.

Every wheel being independently driven eliminates all drive shafts and permits a very low center of gravity. This creates a stable unit which benefits acceleration and deceleration, permits higher speed on curves with a greater factor of safety, and eliminates skidding or slipping. Therefore, the driver is given perfect control of the coach at all times and safety is assured.

Gear ratios range from 4.3-1 to 12.1-1, dependent upon the type of service for which the machine is furnished. Speeds up to 150 miles per hour for rail service are claimed.

The body construction is of modified "air slip" design with a row of windows extending all the way around the machine. All wheel pockets are enclosed with removable cover plates. The entrance and driver's seat are located in the extreme front portion, ahead of the front wheels, which location, together with the abundance of windows, permits the driver unlimited visibility, not only to the front, side, and rear, but also to those portions of the road heretofore obscured from view by hood and fenders of conventional construction.

The machine was designed by Wm. Henry Baker and Henry G. Baker of the Perfect Traction Corporation, and for the present will be custom built.

Too Much Radium

JUST how much radium is reasonable and allowable as a constituent of a bath salt to be used medicinally? The Federal Food and Drug Administration has not ruled on that question yet, but the quantity would not be large. In one case recently it ruled that a shipment of bath salt from France had too large a proportion of radium and was therefore dangerous and might not enter the United States. And how much was that? The proportion of radium was almost inconceivably minute—eight-billionths of an ounce in a pound of bath salts. But that was too much!

It would be extremely difficult to detect and measure such a minute quantity of most chemical substances. But with radium it is not difficult to estimate accurately even smaller quantities than this "dangerously large proportion." It is principally a matter of having the right instrument in the laboratory—in this instance what is known as a gamma-ray electroscope. The Beverage Section of the Food and Drug Administration is completely equipped for analytical work of this character.

Airplane Engineers May Design Next Automobiles

WHEN better automobiles are built airplane engineers will design them, claims William B. Stout, well-known aero-

nautic expert and head of the Stout Engineering Laboratories. And the same applies to other forms of transportation, he says.

"There are definite and good reasons for this," says Mr. Stout. "I can illustrate my point with a story. Not long ago a prominent yachtsman of Detroit wanted a transmission built for his cruiser. He went to a marine engineering firm, told them the horsepower and torque requirements and they designed one for him. It weighed 9000 pounds. The yachtsman put the same problem up to an airplane engineering firm and to meet the same requirements the transmission weighed 1700 pounds! Both were good transmissions. The 7000 pounds was in the difference in the point of view.

"These new streamlined trains which weigh half as much as previous types are good examples of what the airplane engineer can do with our notions on old-fashioned transportation units. If you don't think the present type of road transportation unit is old-fashioned, wait until you see what happens to it in the next few years!

"No airplane engineer would design a Pullman car that weighs 90 tons to transport eight passengers. Neither would he design a motor car that weighs 1500 pounds to a passenger; and when two people ride in a 3000 pound car, that is what it amounts to. It is not hard to see why the principles of airplane engineering will soon be applied to automobiles and other forms of transportation units just as well as to streamlined railroad trains. It is only a question of 'materials and engineering knowledge and we have both,' as Charles B. Bohn recently expressed it."

Intoxicating Candy

ONE of the most insidious results of Prohibition is the growth of the intoxicating candy racket. This particular sweetmeat, consisting of a shell usually coated with chocolate and filled with perhaps half a teaspoonful of alcoholic liquor, was developed into a sizable industry during Prohibition, at which time it was sold particularly from pushcarts in the larger cities. It was and is still being made by only two or three companies which operate somewhat in the manner of the bootlegger. The candy is sold in many cases near schools where children, using their few pennies to purchase it, are later discovered to be half stupefied from consuming several pieces.

The sale of this candy is a direct violation of the Food and Drugs Act and repeal of the liquor laws did not change this regulation. Many seizures of this product have been made and criminal prosecutions are in course of development against manufacturers and distributors.

Governmental suppression of this illicit traffic can never be fully successful. It is, therefore, strongly urged that parents use their influence to see that children do not purchase this drugged candy.

Chemical Brakes Reduce Wear and Tear

"CHEMICAL brakes," as Dr. Arthur D. Little of Cambridge, Massachusetts, calls them in his *Industrial Bulletin*, are substances which slow up natural deterioration from wear or weathering. Thus, "the use of chemical antioxidants is adding thousands of miles of wear to automobile tires, and greatly extending the life of other rubber goods. Lubricating oils exposed to air and either light or heat are now kept from gumming by the same means. A surprising recent development for automobile engine oils is a crystallization controller, which, even when used in less than 1 percent amounts, prevents thickening of the oil, although the temperature goes down to zero or lower.

"A chemical has just been developed which virtually fixes the calcium and magnesium of hard waters, but without removal or precipitation, so that the water may be used for boilers without scale formation, or for laundering with good economy. Deliberate searches are finding practical controls over many long-standing difficulties, and some of the solutions surprise even the investigators."

Big Circuit Breaker

THE impulse oil breaker shown in the accompanying illustration is a single pole of the eight triple-pole breakers being tested for the Department of Water and Power of the City of Los Angeles. Built by General Electric and rated at 2,500,000 kva, 287,500 volts, 60 cycles, it is to be used in the line between Boulder Dam and Los

A 287,500 volt circuit breaker pole

Angeles. It is the highest voltage breaker ever manufactured for commercial use, and has a rated operating time of not more than three cycles on a 60-cycle basis.

In this type of breaker the oil is driven across the arc path under pressure from a piston actuated by the operating mechanism. This results in extremely rapid and positive interruption. It contains about 20,000 gallons less oil than conventional tank-type breakers, and in the interrupting elements there is only 10 percent of the oil content, which means an appreciable saving in oil maintenance costs.

Chemical Exports Grow for 1934

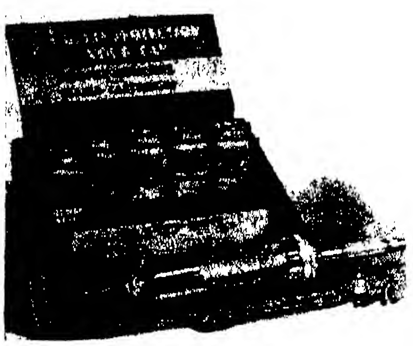
UNITED STATES imports and exports of chemicals and allied products have increased substantially since the beginning of 1934, largely because of increased activity in chemical-consuming industries at home and improved conditions in many foreign markets, according to the Department of Commerce.

Exports of leading chemicals and allied products from the United States during the

first eight months of the year 1934 were valued at 75,000,000 dollars, an increase of almost 25 percent over the corresponding period of 1933, according to preliminary figures. Industrial chemicals led the list with a 40 percent increase to 14,000,000 dollars; naval stores, gums, and resins increased 5 percent to 10,000,000 dollars; paint products increased 32 percent to 9,200,000 dollars; and coal-tar products, including dyes, which advanced 20 percent to 9,150,000 dollars. Exports of fertilizer and fertilizer materials advanced from 4,400,000 to 7,600,000 dollars, an increase of 71 percent, largely on account of increased foreign demand for American phosphate rock. Other important items on the chemical export list which registered gains included sulfur, 8 percent; medicinal and pharmaceutical products, 12 percent; chemical specialties, 16.5 percent; and soaps and toilet preparations, 24 percent.—*A. E. B.*

Grease Packed in Cartridges

CARTRIDGING of grease is a distinct innovation. The old type of grease gun was filled laboriously and messily from cans and drums. The formation of air pockets and the inclusion of dirt were almost unavoidable. To fill the new type the operator merely slips in a factory-loaded cartridge of the desired lubricant. After using the required amount from any cartridge he can remove it from the gun and substitute another. Each cartridge can be used again later, and repeatedly until it is empty. In this way a single gun serves for a full greasing operation involving use of the several different lubricants which are required for proper lubrication of the modern automobile, and a minimum of time and trouble will be devoted to loading and unloading.



Grease gun and cartridges

This new equipment has been developed and perfected by Lubrication Corporation, a concern owned jointly by Standard Oil Company of Indiana and the Bendix Aviation Corporation.

Nitrogen Used in Radio Condensers

A REVOLUTIONARY change in the design of radio power amplifiers has been worked out by Westinghouse engineers in the design of the new KYW station in Philadelphia through the use of the inert gas, nitrogen.

Tuning condensers for radio transmitters generally consist of large metallic plates insulated from each other. The spacing between the plates depends upon the voltage which is to be applied to the condenser in service. In high power transmitters, this voltage is extremely high and the spacing between the plates must be rather great. In order to obtain enough tuning capacity in the condenser, it has been necessary to use large plates or many small plates. Engineers have known for many years that the voltage that condensers will withstand depends upon the pressure of the gas between the plates. By placing the plates in a tank and applying pressure, the plates can be brought closer together and made smaller in physical size, yet they retain the electrical characteristics of the original condensers. In sealing the condenser plates into a tank, nitrogen gas is used because of its inertness.—*A. E. B.*

PINE PAPER

TWO thirds of the annual newsprint needs of the United States are said to lie in the pine forests of one section of Georgia, if and when Dr. Herty's process for making white paper from southern pine is put into operation. Dr. Herty's work, described fully in our May, 1934, issue, has now been carried one step further; he has now shown that rayon can be made from cheap pine.

Instruments Aid Senses of Taste and Smell

MEASURING devices which prevent fatigue of the senses of taste and smell, and establish with scientific precision the chemical and physico-chemical properties of water too small in magnitude to be detected by ordinary analytical procedures, are being employed in researches by the Hackensack Water Company in connection with its study of the effect of stray electric currents upon the quality of water supplies.

In determining tastes and odors, the nose and tongue, under the older practice, functioned unaided. When exerted for prolonged periods these organs were overtaken by fatigue and lost their sensitivity. Hence conclusions were incomplete and often untrustworthy, impeding advances in waterworks science.

To assist the nostrils in identifying the quality of odors in water Gordon M. Fair, associate professor of sanitary engineering in Harvard University, has invented the "osmoscope." In this device is imprisoned the full strength of an odor as it flows from a test flask to the nostrils, preventing any leakage which might destroy the accuracy of the determination. A new process of dilution, performed with mathematical precision, protects the sensory organs and assures exact measurements of the degree of odor intensity and concentration.

The same principle of dilution, employing taste-free water as the diluting agent, is being utilized to determine taste. The new methods provide water analysts throughout the country with a uniform basis for obtaining data of vital importance to public health.

The aim of the New Jersey tests is to ascertain under laboratory conditions the influence of electricity on the quality of water. Evidence that fugitive current is one of the surreptitious forces which sporad-

ically imparts tastes and odors to water supplies has already been discovered in field investigations in northern New Jersey.

"MANY A MICKLE"

COPPER cents totaling 242,503,500 were coined in one day at the Philadelphia Mint recently, when a coining record for any Governmental mint of 3,506,547 dollars in coins was achieved.

New Aluminum Process

A PROCESS for the manufacture of aluminum from alunite ore, with potash as a by-product, has been developed by the Bohn Aluminum & Brass Corporation. Lower cost and higher purity in the metal are claimed for the Bohn process, which is the result of five years of research. A pilot plant to cost roughly 50,000 dollars is to be built to iron out wrinkles in the process. The entire project will require a year for completion. Plans involve a sheet and wire mill in the Detroit area and an aluminum manufacturing plant in some western state where extensive deposits of alunite are available.

Until a few years ago, practically all aluminum, everywhere, was made by the electrolysis of fused bauxite. Aluminum is the most common metal in the earth's crust, but although plentiful in many ores and clays it has not heretofore been commercially practical to extract the metal from any ore save the rich bauxite. Alunite, the ore used in the new process, is not as rich in aluminum as bauxite, but the new process and the fact that potash will be produced as a by-product is expected to bring production costs down to a competitive level.—*A. E. B.*

Streamlining Spreads to Air-flow Trailer

THE streamline motif in automotive equipment is carried out cleverly in a new type of trailer for one of the modern air-flow types of motor-car. When the folk with the air-flow cars want to go places and take things with them, they need only fasten one of the new streamline trailers to the rear of the car, pack it to the gunwales and step on the gas. Even the small tire on the single wheel on the trailer is streamlined, being the General Jumbo, Jr. modification of the streamline airplane-tail wheel tire. It is mounted on a caster-like device which permits the trailer wheel to revolve freely.

Cure for Prussic Acid Poisoning

AN effective cure for prussic acid poisoning of livestock has been discovered by veterinary scientists of the United States Department of Agriculture. Sodium thiosulphate alone or, better yet, in combination with sodium nitrate, if administered in time, will save the lives of animals poisoned by eating plants which for one reason or another have developed prussic acid or hydrocyanic acid. Treatment should be by a skilled veterinarian, and the Bureau of Animal Industry is informing the profession as to the technique of administration and essential results of the experimental work.

Hydrocyanic acid does not develop in dangerous quantities in healthy growing plants but does develop in many valuable forage plants when normal growth has been retarded or stopped by drought, frost, bruising, trampling, wilting, mowing, or other cause. Many plants develop some hydrocyanic acid but, under practical conditions, only a few are actually dangerous. Among the more widely distributed of these are the sorghums, Johnson grass, flax, arrow grass, Sudan grass, wild black cherry, and wild chokeberry (not the chokecherry, which is a different species).

Refrigerator Finish Matched by Electric Eye

TO match porcelain panels for refrigerators the Mansfield Works of the Westinghouse Electric and Manufacturing Company employ a fool-proof electric-eye color matcher. Because of its sensitivity to every color variation, it quickly and accurately chooses panels which match for a cabinet. When producing thousands of units a day, the matcher has proved invaluable in speedy, dependable service. Formerly, all matching was done by eye with the resultant errors due to visual inspection. With the electric eye, no panels have been mismatched in its five months of operation.

In the color matcher, colored light is sent to a sample. The amount of light diffusely

The streamlined trailer has a single small wheel


Instrument set-up for matching colors with photo cells

reflected is sent to a phototube controlling an amplifying tube and an indicating micro-ammeter. The colored light is provided by three color filters red, green and blue. Rays of light pass through the color filter, lenses, 45 degree mirror, and through the window to the sample. A sample having a gloss surface reflects the ray back to the mirror and through the system back to the lamp. The true color of the sample diffuses the light, reaching the phototube by multiple reflection in the integrating chamber. In this way relative readings are obtained which may be compared with those of a standard sample.

Wool Grease Protects Steel Against Rust

THE most satisfactory and economical method of preserving the bright steel parts of stored steel machinery from rust is to coat the metal with partially refined lanolin. The mixtures recommended are 7.8 pounds of lanolin dissolved in one gallon of white spirit, or 8.3 pounds of lanolin in one gallon of solvent naphtha. This quantity applied with a soft brush will cover approximately 1200 square feet of surface.

This information is contained in Engineering Research Special Report No. 12, published by His Majesty's Stationery Office, Adastral House, Kingsway, London, W. C. 2, England. The recommendations are based on the results of tests made, not only in the laboratory, but at sea on vessels passing through the tropics, and also in stores. Even in a badly corroding atmosphere, as in an ammonium nitrate shed, satisfactory protection is reported for a period of three years.—*A. E. B.*

Light-O-Graphs Test Illumination

THERE has been developed a simple device for determining lighting intensities. It is known as the Westinghouse Light-O-Graph and consists of a piece of sensitive photographic paper enclosed in a light-proof envelope. The envelope is colored to a very definite shade and has 10 round apertures through which the sensitive paper is exposed to the light. The sensitive paper, before exposed, is of a light yellow color. As it is exposed to light, it turns darker. In 2½ minutes, under the proper lighting intensity, the sensitive paper will turn a shade as dark, or darker, than the color printed on the protecting envelope. If, however, in 2½ minutes the sensitive paper is lighter than the protecting envelope, then the lighting is not of sufficient intensity.

With this new lighting indicator, anyone can determine in 2½ minutes the illumination conditions at any given spot. The housewife, for example, may determine what the lighting conditions are at her favorite reading chair, at her writing desk, or at her work table in the kitchen.

STEAK BY BREED

THE housewife may soon order an Aberdeen-Angus beefsteak or Guernsey milk or White Leghorn eggs, according to the prediction of the chief of the United States Bureau of Animal Industry. Breed names, in other words, may be used to convey the idea of quality.

Radium Imports Unaffected by Depression

RADIUM, which in recent years has become so important in medicine and chemical research, is one of the few commodities imported into the United States which has not been affected by economic conditions, according to the Chemical Division of the Department of Commerce. On the contrary, importations of this product into the United States have been heaviest since 1929. The Belgian Congo has been the world's chief source of radium, although some has been produced in Czechoslovakia and in 1930 radium ore was discovered in northern Canada.

While the United States is the world's largest consumer, it has imported less than one third of a pound of the substance during the last decade and for this small amount has paid more than 6,000,000 dollars. During this period imports remained fairly steady at around 125 to 170 grains valued at from 400,000 to 575,000 dollars per annum, until 1930 when they advanced to 260 grains valued at 925,000 dollars, the largest amount ever imported during one

year. In 1933, 179 grains, valued at 576,000 dollars, were imported at an average invoice price of 3217 dollars per grain, and during the first seven months of 1934 400,000 dollars' worth was purchased abroad. *A. E. B.*

Diesel Engines for Submarines

ANNOUNCEMENT has been made in Washington that the United States Navy has placed orders for 30 large Diesel engines to be installed in five new submarines. The total cost of these engines and the electrical equipment they drive is 3,948,145 dollars. Twenty of these engines are large units for propulsion service; ten smaller units are for auxiliary service, generating electricity for operating all equipment aboard the vessels.

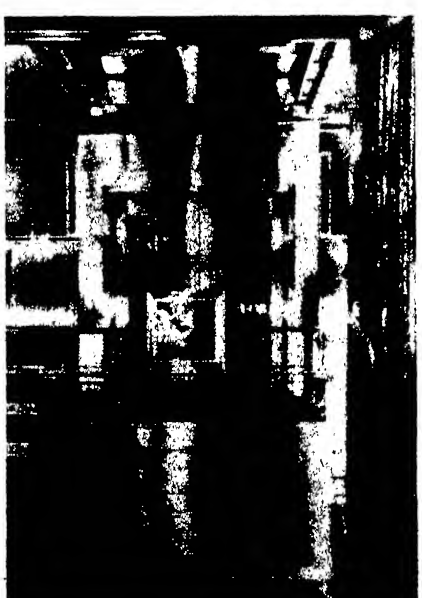
While Diesel engines have been used in submarine service for many years, acceptance by the Navy of light-weight, high-speed Diesel engines now being widely used in transportation and marine service is significant. Submarine service places the greatest importance upon absolute reliability of operation.

Eight of the large engines and four auxiliary units are opposed-piston Diesel engines. This type has two pistons in each cylinder, each connected to its own crankshaft, one above and one below. Advantages of this type of engine are improved combustion efficiency and extreme compactness and light weight for the power developed.

A Unique Office

AN office, decorated and fitted throughout in stainless steel, has been added to New York's list of novelties. The display room pictured here is an exhibit of products produced from Nirosta steel ranging from a coil of wire having a diameter of less than half that of a human hair, to a huge chemical tank capable of handling boiling acids without material deterioration.

The room itself is paneled with Nirosta sheets that have been ground to a satin finish around the borders with a raised polished center. The decorative design has been etched into the metal and the furniture and exhibits include examples of this alloy in



Office decorations of steel

cast, rolled, drawn, spun, welded, wire, etched, and riveted form. There are 48 American steel manufacturers of prominence now licensed to produce this material.—*A. E. B.*

Preserving Proof of Invention

EVERY inventor who is working on a device which he contemplates patenting should first prepare sketches and a description of his invention, which should be dated and witnessed by at least two persons. The inventor has thus established the date of his disclosure, and such evidence should be deposited in a safe place from which it may be produced when needed.

When an invention has been completed, it is advisable to file an application for patent without delay. However, we realize that many inventors today do not have sufficient funds to meet this expense, nor have they safe places in which to keep their disclosures. Therefore *Scientific American* will undertake to act as a depository for such documents. These will be held in safekeeping for two years (unless withdrawn by the depositors) and then destroyed without opening.

To take advantage of this offer, place your papers in a sealed envelope endorsed with your name and address and marked "Not to be opened." Then enclose this in another envelope addressed to A. P. Peck, Associate Editor, Scientific American, 24 West 40th St., New York, N. Y., and mail.

—The Editor.

Can You Taste Salt?

SALT is now said not to be a taste. Scientists claim this because of the fact that salt can be noticed on lips and gums where there are no taste organs. Thus the four traditional primary tastes (sweet, salt, sour, and bitter) are probably now narrowed to three.

Varnish Spreader

THE time necessary for varnishing a linoleum-covered floor has been reduced from the two or more hours required when a brush is used to but 15 or 20 minutes by the use of a newly invented varnish spreader and the development of a free-flowing varnish which goes on smoothly and shows no "brush" marks. The varnish is durable and lustrous, and will not water spot, being waterproof.

In doing the work, the housewife merely pours a little varnish on the floor and "mops" it with the spreader. The device has a removable pad of fabric which is high-piled and has long fibers which act the same as the bristles in a varnish brush.

Varnishing at ease

These fibers, however, are finer than bristles and there are many more of them.

Since the spreader has a long handle, it is unnecessary to get down on hands and knees, as when using a brush, or even to bend over when varnishing a floor.

Cadmium Compounds Kill Insect Pests

CADMIUM, a chemical element related to zinc but less commonly known, has been found to be an effective poison for use against chewing insects such as caterpillars, by Dr. Joseph M. Ginsburg of the New Jersey Agricultural Experiment Station. Reporting his experiments, Dr. Ginsburg states that the compounds cadmium oxide and cadmium hydroxide compared well with lead arsenate, a standard insecticide, when used against tent caterpillars.—*Science Service.*

Bamboos in Established Groves

BECAUSE bamboos in an established grove can grow to a height of 50 or more feet in 4 to 6 weeks, many persons have the idea that they can make money growing this magic plant. They overlook the fact that the grove must be from 10 to 15 years old before the creeping underground stems or rhizomes are strong enough to produce these giant upright grass stems.

Letters constantly are requesting information from foreign plant specialists in the United States Department of Agriculture on growing bamboos for the market. At present American-grown bamboos are of practical value in this country only when grown for ornamental purposes or for local use on farms in the south. Bamboos usually will thrive wherever cotton is grown and also do well in the moist valleys of the Pacific Coast states.

"Although bamboos have a great variety of commercial uses in this country, these uses are so limited in quantity that we cannot advise anyone to grow them for the market in competition with the Orient," say officials of the Division of Plant Exploration and Introduction.

Bamboos are grasses, distant relatives of corn, wheat, oats, rye, and barley. There are only two bamboos native to the United States. The larger of these constitutes the so-called "canebrakes" of the South. While the idea prevails that bamboos like wet land, most species thrive best in fertile, well-drained soil. For about 15 years the Bureau of Plant Industry has experimented in a limited way with approximately 100 varieties of bamboos at a station near Savannah, Georgia, and more recently at Chico, California.

Bamboo shoots served in butter sauce are among the favorite dishes of the Orient and are popular here. But since a bamboo grove must be well established before the shoots can be spared for food, they are an expensive dish and their use so limited that any attempt to grow them in the United States for profit, without a market also for the canes, undoubtedly would fail.

CURRENT BULLETIN BRIEFS

ACID-PROOF EQUIPMENT describes a new improvement in the field of acid-proof chemical stoneware. This is a close grained product of uniform texture, with thin walls, called "deairated" ware. The pamphlet gives full specifications. *Maurice A. Knight, Kelly Avenue, Akron, Ohio.—Gratis.*

RESEARCH—AN EYE TO THE FUTURE is an instructive pamphlet showing how some of the problems of the automobile have been solved by intensive research. *General Motors Research Division, Detroit, Mich.—Gratis.*

CONDENSERS—ELECTROLYTIC, PAPER, MICA, is a pamphlet giving characteristics of a complete line of condensers. *Solar Manufacturing Corp., 599-601 Broadway, New York City.—Gratis.*

SEWAGE CLARIFICATION BY VACUUM FILTERS describes an installation for sewage clarification together with sludge dewatering facilities. *Municipal Sanitary Service Corporation, 155 East 44th St., New York.—Gratis.*

SERVICE CHARACTERISTICS OF THE LIGHT METALS AND THEIR ALLOYS is a report prepared for the purpose of presenting to the engineer, in a brief and concise form, essential data for aluminum and magnesium and their alloys. *American Society for Testing Materials, 260 South Broad St., Philadelphia, Pa.—50 cents.*

THE SHIELDED ARC. An arc may be shielded by enveloping it with an inert gas, which will not enter into chemical combination with the molten metal and at the same time prevents its contact with the air. The pamphlet describes the process fully. *Bulletin 235A, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

RAYMOND ROLLER MILLS AND KILN MILLS deals with a system of drying and pulverizing which is now applied to a wide variety of non-metallic minerals and manu-

factured products that contain too much moisture to be handled by ordinary methods. Other mills for air separation are described. *Raymond Bros. Impact Pulverizer Co., 1315 North Branch St., Chicago, Illinois.—Gratis.*

Railway Statistics of the United States of America for the Year Ended December 31, 1933. Prepared by Slason Thompson, Bureau of Railway News and Statistics. This is the 31st year of publication and the statistics are compared with the official reports for 1932. *Bureau of Railway News and Statistics, Daily News Building, Chicago, Illinois.—Gratis.*

Dowmetal Data Book describes the properties, shop practice, specifications and availability of magnesium alloys which are now competitive in price with other light metals and alloys. *Bulletin 235B, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

Morris Double Suction Horizontally Split Centrifugal Pumps (Bulletin 152) gives examples of designs based on 70 years of experience. *Morris Machine Works, Baldwinsville, N. Y.—Gratis.*

Handbook of Super de Lavaud Cast-Iron Pipe Centrifugally Cast tells of the characteristics of this pipe which is given a much finer and closer grain than is found in cast-iron pipe produced by other processes. *Bulletin 235C, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

Insulation Testing Equipment (Bulletin No. 934) discusses such subjects as insulation, dielectric strength, resistivity, and dielectric constant and power factor. *Sound Engineering Corporation, 416 North Leavitt St., Chicago, Ill.—Gratis.*

A "Different" Wi-R-ope Handbook describes the construction of wire rope as well as splicing and the miscellaneous operations in using such rope in the oil industry, elevators, and for marine as well as for other purposes. There are numerous tables and illustrations. *Bulletin 235D, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

Chemistry and Wheels tells that the automobile is a chemical factory on wheels and shows by graphic diagrams how this is the case. *General Motors Corporation, Research Division, Technical Data Section, Detroit, Michigan.—Gratis.*

Sarco Temperature Regulator for Heat Control in Industry describes a system of temperature regulators operating by liquid expansion, the thermostat, connecting tubing, and plunger being filled completely with a special hydrocarbon oil. *Bulletin 235E, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

Self-Calculating Resistance Charts. Values and associated data may now be determined without mathematics (or headaches) by means of this collection of self-calculating resistance charts. The charts provide a simple method for determining the relation between resistance, voltage, current, and power of any resistor or rheostat. *Hardwick, Hindle, Inc., 40 Hermon St., Newark, New Jersey.—Gratis.*

The Story of Learning is a well illustrated booklet describing a new enterprise. *Rose-Croix University, Rosicrucian Park, San Jose, California.—Gratis.*

FIRE AT SEA!

(*Continued from page 85*)

ships. To American navy officers trained in the exact methods of all navies, the knowledge which we have always had of the American Merchant Marine, and of the loose laws which govern it, the dangerous conditions in the American Merchant Marine have stood before us always as a ghastly prophecy."

Admiral Fisk's attitude is bred of his realization that the national Merchant Marine is counted upon to play an indispensable part as an adjunct of the battle fleet in time of a foreign menace. His denunciation is really directed against those weaknesses that do exist in some of our merchant fleet and its personnel, and is not intended to discredit those fine men who have rightly won acclaim because of their splendid and even spectacular actions at sea. Even so, it must be remembered that the nation's money has been spent in sums of many millions in later years to promote our Merchant Marine by building craft like the *Morro Castle*, and behind this substantial help has lain the purpose of thus providing ourselves with vessels and well-trained men that could collaborate with the Navy in time of need. Manifestly, steps must be taken to see that the personnel of these ships shall be wholly qualified and so disciplined that they can at least battle intelligently with fire aboard or meet resourcefully and courageously any other situation at sea touching first the safety of the ship and then the well-being and security of the passengers entrusted to their keeping.

The heartening aspect of this subject is that we are positively assured that ships can be built, without inviting excessive cost, that will be far better safeguarded against the hazard of fire than many of the liners afloat and in active service today. This much the naval architect and groups of contributive specialists and industries have shown to be attainable. Nevertheless, a grave weakness remains in the human equation of the problem; and only an aroused public opinion and popular insistence will bring about the necessary corrective measures and their enforcement. The carefree attitude of the traveler should not be reflected in the conduct of the operating force of our passenger liners. Discipline, efficiency, and continual alertness must be assured. Our Merchant Marine, like the Navy, should be able to live up to any prescribed standards. The nation has proved time and again that it has all the men it needs to maintain its prestige upon the sea. Let us see to it that we recruit from them such personnel as will make our merchant service a source of pride.

Books SELECTED BY THE EDITORS

(*Continued from page* 61)

fied by individual variations among healthy people; and finally, as to the justifiable anticipations of advances to be gained through the newer knowledge of nutrition and food values." This is the publisher's statement and we find it amply justified in the 277 pages of this book. The author is a professor of chemistry at Columbia University and a widely known scientific authority on food and nutrition.—$2.70 postpaid.—*A. G. I.*

RAILWAY ENGINES OF THE WORLD

By Brian Reed

IN time the steam locomotive will probably be as dead as the dodo. The reciprocating engine will probably be in use in the time of all of us now living, but steam propulsion was recently given a serious blow by the use of Diesel engines by the Union Pacific System and other lines. The present book illustrates many unusual types of locomotives in use in Great Britain and in Europe as well as those in South America, Asia, Africa, and Australia. The author tells enough about each type illustrated to show that locomotive designers all over the world are alive to the opportunities for improvements.—$1.90 postpaid.—*A. A. H.*

THE BRITISH AIR ANNUAL

THE Air Annual of the British Empire, 1934-35, is an interesting volume in three languages (English, French and Spanish), containing some 840 pages and a large number of illustrations. It covers civil, military, and naval aviation in the British Empire, airplane engines, accessories, the latest wrinkles in construction, and in general constitutes an up-to-date encyclopedia of the art. It is of as much interest to serious American readers as it is to British readers.—$6.30 postpaid.—*A. K.*

HALF MILE DOWN

By William Beebe, Sc.D.

IN this most readable volume the widely known Director of the Department of Tropical Research of the New York Zoological Society, better known to millions of fascinated readers simply as "Beebe," brings together the whole story of his work with the bathysphere. The main text is non-technical but in a 213 page appendix he assembles the more technical data about the bathysphere and the forms of life seen from it. The book is well illustrated and produced, and is sure to be a scientific best-seller. It is essentially a narrative.—$5.20 postpaid.—*A. G. I.*

NORTHERN LIGHTS

By F. Spencer Chapman

THIS account of the British Arctic Air-route Expedition to Greenland is a dramatic narrative of a large scale arctic expedition, with plenty of thrills. It concerns mainly the east coast of Greenland, but sledge journeys were made to and across the high interior ice plateau, including one man's winter sojourn in solitude there for five months. The adventure is prefaced by a foreword by Admiral Byrd.—$2.70 postpaid.—*A. G. I.*

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

CONTENTS · MARCH · 1935

COVER

28118 / '36

BEFORE the American Mathematical Society and the American Association for the Advancement of Science, in a meeting at Pittsburgh, Professor Einstein recently attempted to prove a problem which has occupied his part-time thoughts since it arose in 1905, as a result of his special theory of relativity—that of the equivalence of energy and inertial mass. This problem throws light on the physics of atomic nuclei and provides a useful tool of research.

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ACROSS THE EDITOR'S DESK

THE fact that railroad transportation equipment is at the present moment in a state of flux is obvious even to the most casual observer. Will railroad motive power of the future be steam, electric, or Diesel-electric? In order to present to our readers these three sides of this intriguing question, we have made arrangements for the publication of three articles, the first of which will appear in the April issue. William C. Dickerman, President of the American Locomotive Company, who prepared this article, says: "We have long been equipped, not only on the manufacturing but also on the research and designing sides, to supply all the power needs of our customers, whether they be for steam, electric, or Diesel-electric units. Therefore . . . possibly I can be objective in discussing railroad power problems." The information given in these coming articles will furnish a source of data which will permit the reader to view the problems of the railroad from an unbiased standpoint.

●

"STRANGE as it may seem, the insane, of all people, are sane . . ." says Professor G. H. Estabrooks, of Colgate University, writing for the April issue under the title "The Sanity of Insanity, or the Insanity of Sanity." Just what constitutes sanity and what constitutes insanity? The minds of the insane work the same as our own, only more so—or less so. Again to quote Professor Estabrooks: "In the following pages you will see yourself in one of those funny circus mirrors. It may distort or exaggerate but through it all you will recognize the original of the caricature. There, but for the grace of God, go I . . ."

●

PAINT—and this word covers a multitude of products which are used for an equally large number of purposes—is undergoing a tremendous development which will have a direct bearing on the lives of everyone. A broad yet comprehensive article on the subject of paint, written by Philip H. Smith, who has prepared many of the fine industrial articles which have appeared in these pages during the past few months, will be the next in our series dealing with general housing conditions, the first of which appears on page 140 of this issue. Mr. Smith has made a careful and intensive study of paints, their compositions, their uses, and the many improvements which science has made in paints recently. Out of the wealth of material so obtained he has built an article to be published next month which will carry home to every reader the vital necessity for the proper use of the proper paint in the proper place.

COMING

"There's Life in the Old Iron Horse," by William C. Dickerman, President of the American Locomotive Company.

"The Sanity of Insanity, or the Insanity of Sanity," by G. H. Estabrooks, Professor of Psychology at Colgate University.

Paint: An up-to-the-minute survey of paint and its uses, by Philip H. Smith.

The construction of the Grand Coulee Dam in the state of Washington.

A glimpse behind the scenes with the "ad" photographer, by Jacob Deschin.

"Flying High for Comfort," by Reginald M. Cleveland.

●

CENTURIES ago there was a huge dam on the same spot where engineers are now working on the construction of the Grand Coulee Dam, 92 miles west of Spokane, Washington. The original dam, however, was not an engineer's product. A huge glacier descending from the north reached the bed of the Columbia River and dammed it. The result was the formation of an extensive valley which by the hand of man will soon become a vast reservoir in which will be stored the impounded waters of the Columbia River. The new dam which will do this work will be constructed in two units—high and low dams—and will be described in an article to appear next month.

●

"BORROWING a trick or two from the movies and adding a few of their own, modern commercial photographers are daily turning out pictorial miracles undreamed of a few years ago. These arresting advertising illustrations . . . bring these magicians of the sensitized celluloid or glass as much as 500 or 1000 dollars for a single picture. . . ." Thus is introduced an article by Jacob Deschin, which in an early issue will take the reader behind the scenes with the "ad" photographers and tell him something of the ingenious development work which has been done to bring the art of commercial photography to its present stage. Those who have followed our articles on photography for the advanced amateur will find here many hints that can be applied to their own work.

●

MUCH has been written about the possibilities of flight in the stratosphere and of the increased efficiency which may be expected when this stage has been reached in the development of aviation. As yet, however, the true stratosphere plane for transport work has not been developed; nevertheless, airline operators are sending their huge planes into altitudes often as great as 20,000 feet. Only a year or two ago such altitudes would have been considered as no place for a passenger plane except when necessary to hurdle a mountain range. Just why this important change in flying operations has taken place and what technical developments have made it possible is told in an article entitled "Flying High for Comfort," by Reginald M. Cleveland—coming soon.

Editor and Publisher

Books SELECTED BY THE EDITORS

LAST OF THE WIND SHIPS

By Alan J. Villiers

THE romance of the square-rigged ship will undoubtedly persist long after the last of them has passed from active duty, and that period of time will probably not be in the far distant future; although in 1921 there were 304 sailing ships officially listed as visiting Australia, the number dropped to 138 in 1922. At the present time it has decreased to 21. Because of the rapidly dwindling numbers of these picturesque vessels, the present book, "the swan song of sail," stands as a memento of the days when sailing ships carried the commerce of the world. The present book deals almost exclusively with the voyage of the *Parma* from Australia to England with a cargo of grain. The first part of the book is devoted to the story of the voyage and to it are appended several tables giving the records of sailing ships in and out of active service. The last part of the book is by far the most interesting, consisting of a series of 208 photographs taken during the voyage and beautifully reproduced on heavy coated stock. These photographs with their short captions tell a running story that will capture the reader completely. The tang of salt air hovers over the entire volume.—$4.25 postpaid.—*A. P. P.*

GENERAL SHORT-WAVE AND PUBLIC ADDRESS MANUAL

By Sydney Bass and Herman Cosman

A COMPILATION of short articles, together with numerous tables and charts, makes this book of great value to short-wave radio experimenters. The articles deal with definite design and construction of all types of short-wave radio receivers and both simple and complex transmitters. Public address systems—high-powered amplifiers and loud speakers—are also dealt with, making a well-rounded presentation. In the front of the book are tube charts and base diagrams as well as listings of short-wave stations throughout the world.—50 cents postpaid.—*A. P. P.*

WEBSTER'S NEW INTERNATIONAL DICTIONARY (*Second Edition*)

HERE is a book so monumental in size and scope that it is impossible for the reviewer to do much more than quote statistics. The publishers of this revised unabridged dictionary call it the greatest single volume ever published and it certainly appears to warrant that description. In the regular edition it is 9¾ by 12¼ by 5 inches thick. It contains 600,000 entries, with 12,000 of the terms illustrated. There are 3300 pages, many in colors and half-tone. The cost of this volume is estimated to have been one million three hundred thousand dollars. A corps of experts drawn from various fields constituted the editorial staff. Incidentally, one of the illustrators is J. F. Odenbach, whose work has appeared from time to time in SCIENTIFIC AMERICAN. Regular style, in buff buckram binding, indexed.—$21.00 postpaid.—*A. P. P.*

FISHING A TROUT STREAM

By Eugene V. Connett

A NOVEL approach to the esoteric art of luring the wily trout with a fly has been worked out by this author. Mr. Connett, a trout fisherman of no ordinary ability, spent considerable time with a photographer along one of his favorite streams, and the result is a collection of 94 beautiful illustrations which practically take the reader by the hand and show him exactly where to lay his fly with the greatest expectation of results. The photographs are accompanied by short paragraphs giving necessary explanatory notes. The library of a dyed-in-the-wool trout fisherman will forever be incomplete if it does not include a copy of this book. —$7.70 postpaid.—*A. P. P.*

BIRTH CONTROL—ITS USE AND MISUSE

By Dorothy Dunbar Bromley

THE introduction to this book is contributed by the widely known gynecologist Dr. Robert Laton Dickinson who characterizes it as the first volume to cover the whole subject of birth control for the general public. "I know of no other volume," he writes, "available to the general public and couched in terms it can understand, which covers anything like as much ground as this." Various chapters treat the spacing of children, abstinence, the "safe period," popular fallacies, dangerous drugs and devices, advertised methods, selected methods, sterilization, clinics, sterility, and so on. "The purpose of this book," says the author, "is to summarize and interpret for the lay reader the authoritative medical findings regarding contraception and its allied problems." After reading this volume we consider that it accomplishes that purpose and is an excellent scientific book.—$2.70 postpaid.—*A. G. I.*

AUDELS MATHEMATICS AND CALCULATIONS FOR MECHANICS

By Frank D. Graham, M. E., E. E.

THIS is a 245 page pocket reference book for intelligent workmen and others who wish to learn arithmetic, plane, solid and descriptive geometry, algebra, trigonometry, and the calculus. The book claims to render these subjects "easy"; doubtless meaning relatively easy, since mathematics is not easy but requires hard labor. The second half of the book is devoted to electrical and mechanical calculations and from end to end it is a *practical* book, for the practical man.—$2.00 postpaid.—*A. G. I.*

THE ODYSSEY OF HOMER

Translated by T. E. Shaw (Lawrence of Arabia)

THE translator modestly says: "The 28th English rendering of the Odyssey can hardly be a literary event, especially when it aims to be essentially a straightforward translation." We disagree. Its straightforwardness should make it the more acceptable to those who see therein both the honesty and genius which we saw in our first delighted reading. Dr. Henry S. Canby has said of this fascinating "oldest book out of Europe worth reading for its story": "I recommend for everybody over 12 Lawrence's Odyssey." This translation was widely acclaimed when first published in 1932, and it is expected that this new popular edition will achieve a wide renown.—$1.90 postpaid.—*F. D. M.*

THE COSMIC CYCLE

By Max Waldemar Kurniker

THOSE who rebel against what they call "orthodox" science should procure this book, which is stuffed with unorthodox hypotheses about the origin of the sun and planets and the behavior of the moon, together with a whole bandwagon load of other things. It is said to be the presentation in English of a hypothesis known in Germany as "Hoer-

(*Please turn to page 167*)

HARVESTING AMERICAN-GROWN RUBBER IN CALIFORNIA

GUAYULE, a domesticated wild desert shrub which yields 15 to 19 percent rubber, is harvested at Salinas, California, by a subsidiary of the Intercontinental Rubber Company, which employs tractors for drawing diggers that uproot the plants. After drying in the sun these plants are picked up by another tractor-drawn machine (shown above) which feeds them into a cutter, chops them into pieces and blows these pieces through the arched conduit shown, into a trailing truck. At the mill the chopped plants are fed through rotating tube mills containing flint pebbles. This releases the rubber.

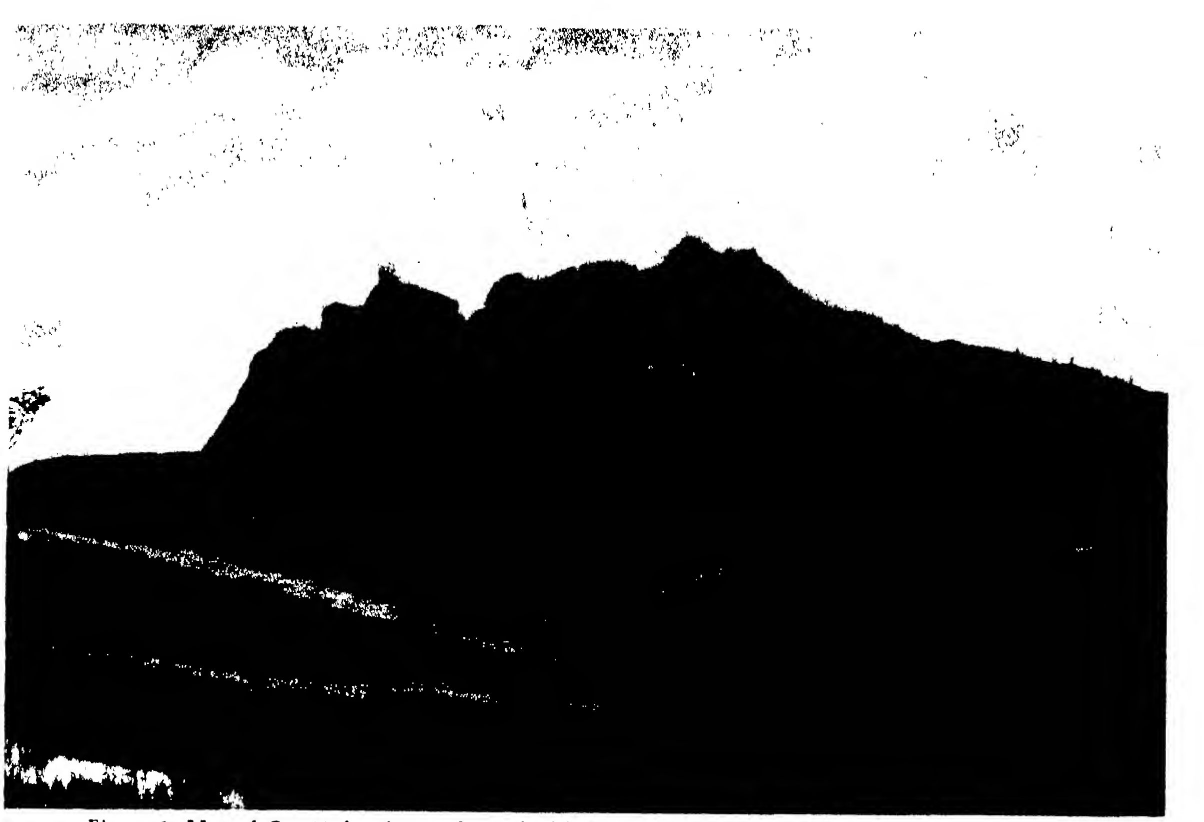


Figure 1: Mound C, 200 feet long, after it had been cross-sectioned, revealing its varicolored bands

EXPLORING PREHISTORIC GEORGIA

The Largest Archeological Expedition Yet Undertaken In America Has Yielded Remarkable Results on a Site Later to be Opened To Visitors as a National Monument

By A. R. KELLY, A.M., Ph.D.

(Part 1)

IN December, 1933, many different types of work projects were undertaken under the auspices of the CWA to provide jobs for the millions of unemployed men in the United States. The national economic crisis created a situation and set up the machinery by which it was possible to carry on large-scale archeological explorations hitherto beyond the means of even the most heavily endowed scientific institutions.

The Smithsonian Institution at Washington sponsored five expeditions to do archeological exploration under CWA auspices. With one exception all of the projects were located in the southeastern United States, an area known to be rich in archeological sites and remains, comparatively unexplored, and unknown to students of American prehistory.

In central Georgia, near the city of Macon, east of the Ocmulgee River (map, page 121) and continuing southward downstream, were located several large Indian mounds and numerous indications, in exposed surface deposits of midden materials and pottery, that the region had once been densely populated by aboriginal Americans.

EARLY history yielded excellent documentary evidence to the effect that "Old Ocmulgee Fields," as the location was called by 18th Century commentators, had been the site of an important Creek Indian settlement, the probable center or capital of the famous Creek Confederacy. The epic recital of tribal beginnings and migrations, as given in the origin myths obtained from Indian informants living within the period of white contact, implied that here had been the land of Canaan to the ancestors of the Creeks after they had completed their long trek from some obscure quarter "to the west." In the fertile plains of the Ocmulgee, close to the point where the river broke through the foothills of the piedmont belt to continue eastward to the coast, the ancestral tribesmen "sat down," dispossessing and partially absorbing an earlier Indian population already settled upon the land.

Ethnological reconstruction from Indian lore and the testimony of early European observers serve to give only a vague perception of the tribes found by the first comers among the Creeks

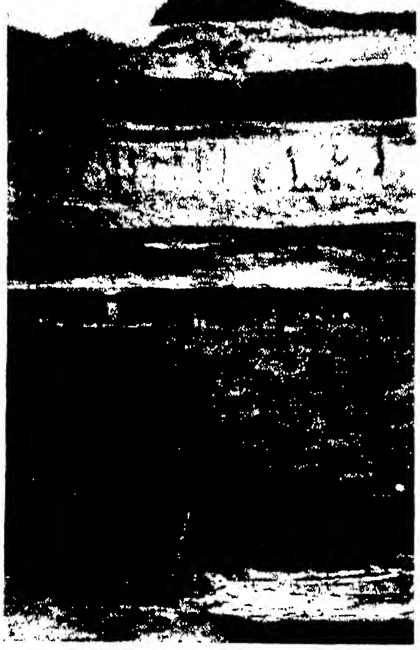


Figure 2: **A closer view of the several bands shown in Figure 1. These were deposited by Indians of the Ocmulgee-Oconee River basin.**

No very definite idea of time intervals can be ascribed to the events recorded in folk memory. It is enough at present to indicate that the waves of tribal migration resulting in the ultimate preempting of the Ocmulgee territory by the Creeks took place some time before the coming of the white colonists.

The first European settlers found two dominant tribal groups peopling what is now the southeastern United States: to the north of the area were the Cherokees; to the south were the various tribes bound together in a loose political confederation to form the Creek Nation.

THESE two groups held the territory and barred the western passage to the encroachments of the white colonists. They held the piedmont region beyond the coast, and for over a century were the real balance of power in the struggles of the English, the Spanish, and the French to gain possession of the land.

Scientific examination of the existing data led to the conclusion that neither the Cherokees nor the Creeks were the autochthonous population in the area. Language and certain vital elements in the culture of the Cherokees are derived from the parent Iroquoian branch in the northeastern woodland region; the Cherokees are an isolated offshoot who migrated to the south, and were later separated from their Iroquoian kinsmen by the surrounding wall of unrelated tribes.

The Creeks were combined with many other tribes in the southeast, grouped on the basis of linguistic relationships under a large parent family language known to us as the Muskogean. There are indications that culturally the various tribes were most dissimilar. Perhaps some of the more divergent peoples were completely alien elements, absorbed and adopted into the growing nation, as the Creeks grew in numbers with each succeeding wave of migration.

The crux of the archeological question presented to the expedition directors sent to explore the mounds and village sites near Macon revolved about the identification of the historic remains, and the relation of these settlements to possibly older occupation levels belonging to an earlier people present on the Ocmulgee before the coming of the Creeks.

Hypothetically, these older inhabitants might have been the little known Hichiti, some remnants of whom had remained on the Ocmulgee site until 1715 when the removal necessitated by the encroachments of white colonists led to a general hegira to the Chattahoochee and the swamps to the south.

On the other hand it was conceivable that the various tribes had converged upon the Oconee and Ocmulgee rivers over a longer period of time; that the migration was more a slow process of infiltration of numerous populations dislocated to the west and northwest, and pressed south in scattered bands upon one another. Cultural and linguistic integration proceeded slowly. The Creeks emerged in historic times as the dominant group, after a long proto-historic, possibly quite prehistoric, interval in which the diverse tribal cultures went through a "melting pot" process. In other words, older stratigraphic levels of occupation, if present, might belong to ancestral stems of historic surviving tribes. The term, "proto-Muskogean," serves in a rough way to indicate the potentialities involved in this assumption.

THE geographic setting of the Macon site is important in understanding the implications of discoveries made during the last seven months of archeological exploration. Briefly, it will suffice to indicate that the Oconee and Ocmulgee rivers are twin tributaries or forks of the Altamaha, which carries on to the Georgia coast. Both rivers rise in the highland interior of central Georgia and break through the hilly frontier of the piedmont within 35 miles of each other. Milledgeville, on the Oconee, has Old Oconee Town and Rock Landing as surviving landmarks, reminiscent of the time when this site served as an important transhipment and portage point in the coast hinterland traffic of aboriginal days. Columbus, on the Chattahoochee, and Augusta on the Savannah River to the east, complete the circuit of strategic points in Georgia located on the fall line dividing the piedmont from the coastal plain. It is significant that each was an important center of population and trade in historic Indian times. It would seem that the same geographic factors which have led to the development of thriving industrial and commercial centers today operated in the flux of moving tribes and primitive barter 200 years or so ago.

Figure 3: **The 14-step, clay-moulded stairway at Mound C**

A series of bluffs, flat and extensive on top to give a plateau character, encircle the meandering course of the Ocmulgee River east of Macon. Approximately one square mile of territory is covered by the habitable area on top of the bluffs. This plateau has been cut into three segments by two railroad excavations of the Central of Georgia railroad. The underlying geological formation shows strikingly in the cuts and deeply eroded sides as a dark, reddish-brown clay loam, hardening to a stony consistency under weathering.

Upon the table land expanse of these bluffs are located five mounds, three of which have been at least partially explored by the present field party operating at Macon. Reference will be made to discoveries at Mound A (see map), a huge pyramid with a flat, truncated summit, extending 45 feet above the natural terrain. Mound B, immediately adjacent to the large pyramid, is much

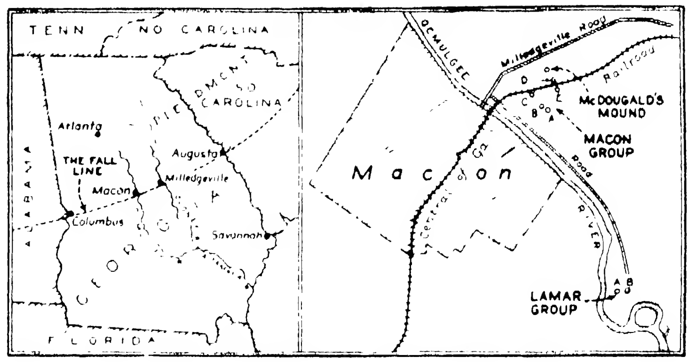
smaller, only 12 feet above the plateau floor and almost completely destroyed by one of the railroad excavations through the plateau. Mound D, at the northern end of the escarpment, had produced perhaps the most interesting developments on the bluffs east of Macon.

On the east side of the river, between the plateau and the Ocmulgee river, located on a smaller rise or secondary terrace not topographically related to the plateau, is the site of Mound C, the most unusual mound structure in the Macon mound group.

SOUTH and east, following the winding course of the Ocmulgee, at a distance of two and a half miles from Macon, the river plain broadens to a span of five miles or more. The terraces and hills no longer overhang the margins of the stream. The area is subject to periodic overflow. Reeds and swamp growth impede the movement of the turgid waters over low-lying flat river bottom. Here is the site of the Lamar mounds (map) and the extensive village remains with numerous house rings extending between the two higher mounds. These people were swamp dwellers, their houses built upon artificially constructed hillocks to escape the inundation of a swollen river. It would be difficult to imagine a more different environment, a more contrasting mode of life, than that which confronted the respective villagers of swamp and plateau.

For seven months, first under CWA auspices, then under a reorganized FERA authority, the field expedition has proceeded with the archeological exploration of the mounds and village site mantling the east plateau; also with Mound C, almost within the suburbs of Macon, and the Lamar village site in the swamps southeast along the Ocmulgee. Three hundred and sixty men were engaged in the work at the peak of activity. A specially trained corps of 45 CWA workmen, selected from the higher professional groups, were trained for three months in an archeological night school to fit them for supervisory duties as trowelmen, engineering assistants, laboratory technicians, and foremen of excavations.

Sight of such a large force of men was rather dismaying to the scientific directors of the project. Ordinarily, archeological field parties, even when rather large and well appointed, do not run over 30 men, including supervisory staff. That is, of course, in the mound



An orientation map showing entities named in the text. Readers may visit the site now, although its formal opening will not take place for several years

areas of the United States; in Mexico or the Near East, larger crews of native laborers might be employed. However, the archeological school proved effective beyond the hopes of the directors. The men, nearly all formerly high-salaried executives in business or the professions, were intensely interested in the work. The writer of this article, who conducted the class, has never seen such diligent application to study, such earnest effort to learn, in any university student body. They became so proficient in their special tasks that they might now serve as trained artisans without further instruction on any normally constituted archeological field party.

Work began with two full-fledged field parties in action at two main sites, the Lamar mounds and village, and Mound C. Archeological discoveries of primary importance came thick and fast.

Mound C (Figure 1, Figure 2) of the Macon mound group had been partially destroyed, about three fifths of the north section having been cut away in 1843 when the Central of Georgia railroad cut a right of way through the plateau. A remnant structure stood as a shell towering above the terrace, the stratified clays and basket-laid sand of the mound defying the ravages of time and the elements. Slump earth in the old railway cut had formed a mound talus mantling the north side of the mound. Human bones, beads, pottery, copper and stone artifacts, invited the pothunters and relic collectors to surreptitious digging into the exposed face.

In three weeks workmen had cleared the talus slope of all slump material and had cut a scarred cross-section through the longitudinal axis of the mound. Archeological trenching, with straight, vertical profiles neatly dressed, brought out in sharp relief the remarkable schematic arrangement of multicolored sands and stratified clay bands which marked the complex composition of Mound C.

Mound C was found to be unique. A large, conical, truncate structure, 30 feet high, over 200 feet long, the mound in cross-section showed four series of banded clays, each of different color, consistency, and thickness and each marking the summit of an earlier unit of mound construction. In short, there were really four, possibly five, mounds to be made out in the cross-section through Mound C. Each mound was finally determined to be conical in shape, with a flat, truncated summit, mantled with clay 12 to 14 inches in thickness. The lowest clay summit band was slate blue in color, the second and third were yellowish in tinge, the fourth was a brilliant red three feet in thickness, the topmost mantle was an orange red varying several shades from the bright crimson of the underlying band. Four to nine feet of basket-laid mound earth and various-colored sands, constituted the body of the mounds beneath the clay caps.

Between the second and third mound summits a uniform stratum of water-laid sand a foot in thickness confronted the archeologists with an unusual situa-

***Figure 4:* A skeleton (bottom, center) left in place with the surrounding earth cut away, leaving it on a raised platform**

Figure 5: **An interment within a tomb of logs, which exist only as log-mould**

tion, a problem in primitive engineering. For how could sand have been deposited in running water on the level top of a mound constructed upon a natural terrace which drained sharply downward on all sides toward the river? Water will not run uphill, and not in any recent geological time had the land been high enough around Mound C terrace to allow for sandy depositions on mound tops.

THE tentative suggestion made at the time the water-laid sand on top of Mound C was discovered was that the Indian architects had carried considerable quantities of river sand in baskets to the summit of the mound where it was dumped irregularly over the clay mantle. A raised lip or flange of basket-laid clay projected above the shoulders of the mound, forming a round dike on the summit in which to impound rain waters. Heavy rain fell. The sand was gathered up in rapidly developing freshets, the water seeking lower levels where the summit construction was uneven. As the running water found a natural level the sand was deposited. Gradually the smooth, level floor grew over the surface of the mound within the dike construction. Then another clay band was built over the water-laid sand.

Mounds of multiple or composite construction are not unknown, but a mound composed of four or five unit structures contained within is something new in archeology. In Mound C, the marked selection of different colored sands and clays, schematically arranged in serial bands, mantling summit and slopes of the conical truncate mounds, implies a deliberate plan on the part of the mound architects. Color symbolism, however difficult or impossible it may be to identify in its exact ethnological meaning, is quite evident.

So intricate was the internal structure of Mound C—so striking the arrangement of colors—that the archeologists in charge of explorations decided that simple engineering records of levels, profile readings and draughtings, were wholly inadequate to do justice to the creation of the prehistoric architects. A competent artist, Mrs. Carolyn S. Meriweather, was commissioned to make an oil painting of the north profile of the mound, showing essential structural features and color contrasts as they were uncovered and dressed by the trowel and spade of the workers. To archeologist and layman alike it may appear impossible that the mound mosaic should have been so brilliant as the painting indicates. Yet many visitors were privileged to be present during the course of excavations at Mound C, and can testify that the artist has painted a realistic canvas. Her picture is both a scientific and an artistic record.

One additional discovery at Mound C is of special interest. Within the west shoulder of the mound a flight of clay-moulded stairs (Figure 3) was found, 14 distinct steps ascending from ground level to the top of the first unit of mound construction. The steps were about six feet in width, six to eight inches high.

Mound C appeared to be a burial mound. Interments were made underneath the base of the mound, within the body of the mound and covered by the clay bands or summits, and later, intrusively into the slopes of the final complete Mound C, this representing the most recent and modern level of occupation. All these burials were made in pits, and many of them had burial furniture associated with the skeletal remains.

Three levels of occupation are indicated. The topmost intrusive burial pits were of historical date, glass trade beads and iron objects having been found definitely associated with flexed or contracted skeletons. The pits within the mound represented predominantly secondary burials—that is, the bodies had been exposed on platforms or secondarily reburied in the mound pits, only the long bones, skull and jaws being moved in the final reburial. No objects of historic connection were found with these burials made within the body of Mound C. They fix the chronology of Mound C as definitely prehistoric. The burials with iron and glass outside the mound are historic and intrusive.

The oldest burials and occupation level indicated by the chronological series of pit burials at Mound C were found underneath the base of the mound (Figure 4).

IN one instance a tomb of logs encysted what appeared to be the interment of a person of more than ordinary importance (Figure 5), and in another interment (Figure 6) thousands of bone and shell beads, strung into necklaces, arm bands, anklets, probably woven into a mantle, covered the mouldering bones from head to foot. Strangely enough, pottery and other prized objects often found with Indian burials were not found in this grave. The tomb explored beneath the core mound at Mound C required the most expert art of the trowelmen to reproduce the details of the timbered walls, preserved only as log-mould uprights, with the sleepers or cross pieces clearly indicated on the floor of the grave beneath the bundled bones of the single burial.

(To be continued)

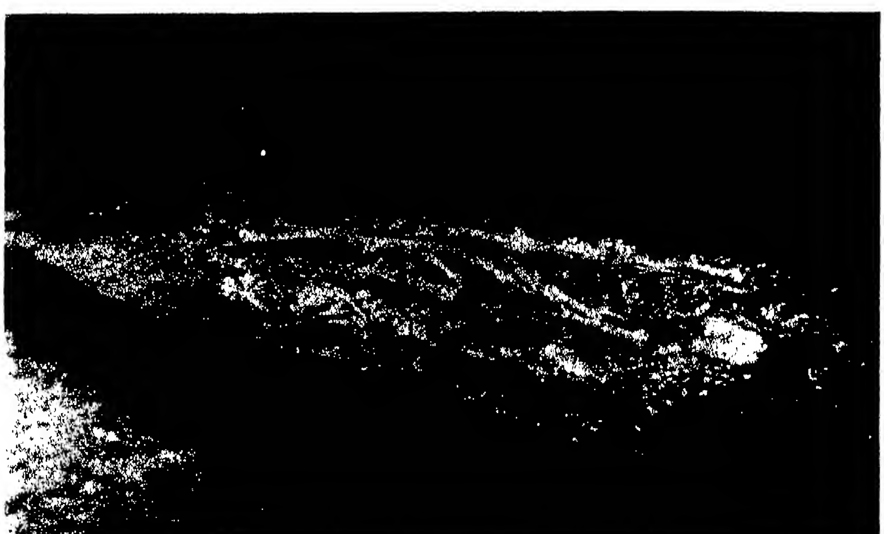


Figure 6: **Thousands of bone and shell beads covered the bones of this skeleton, which was quite evidently that of some person of considerable importance**

OUR POINT OF VIEW

Naval Competition

AFTER abrogation of the Washington Treaty—what? This is the question on the lips of Admirals as well as of the public generally, of statesmen anxious to maintain peace and security for their several nations as well as of devotees to the creed of disarmament by example. Hailed upon its signing as one of the greatest instruments for forwarding the cause of international peace and co-operation, this document, setting up the famous 5-5-3 formula for war vessels of Great Britain, the United States, and Japan, respectively, has been doomed since Japanese militarists began their triumphant march into Manchuria, since this powerful clique began scrapping treaties and making our friends, the Japanese people, like it. Or was it doomed even from the start?

Abrogation comes as no surprise; fair warning had been given. The hope that springs eternal—and often causes insensate delays in preparation against the inevitable—did, however, lead statesmen to do their utmost to prevent it. And now that it is a fact, no one knows just what comes next. Certainly, so far as national emotions go, there is reason to feel that an era of competitive naval building is in the offing. Hard facts, however, make this look extremely doubtful. This country has no wish to build against either Britain or Japan. That we should covet anything of theirs is unthinkable; that we should be jealous of either, unconscionable.

The treaty still has two years to run. And while statesmen talk of the possibility of arriving at some agreement, they are not really optimistic. The nations, therefore, are taking stock of their naval establishments. France and Italy will have a free hand and will, no doubt, take up where they left off in 1922. Already, our Navy plans to build five against Japan's three, to maintain the treaty status regardless. And that's a large order, for with completion of our present program, we shall still be shy 70-odd ships. Perhaps our construction won't be necessary for we may now achieve a happier relationship with England than we have had heretofore. This possibility—nay, probability—is of Japan's making. In trying to widen the gulf between England and America, her engineering went awry and she built a bridge instead.

To the Japanese people, we repeat that we haven't the slightest desire to hurt them. But let us warn them that their military leaders are giving Japan the name of being the world's bad boy. These militarists are indeed Japan's own greatest enemies.

To Combat Crime

"THAT a national scientific and educational center be established in Washington for the better training of police." Thus reads number one of an eight-point plan to wipe out crime, advanced by Attorney General Cummings at the Conference on Crime called by him in Washington recently. Other points were concerned with state and federal co-ordination of control; youthful delinquency; violence in strikes, industrial conflicts, and racial antagonisms; abuses of the parole system, of bail, and criminal procedure; "lawyer-criminals" and "political protection"; and glorification of criminals by the press. The program is indeed a practical one and should go far toward wiping out what has become our national disgrace; but it is not comprehensive enough.

Except by inference, organized crime was not considered in the eight-point plan. It is all very well to fight the "accidental" offenders, the petty racketeers, and the blood-thirsty rats who, with machine-gun in hand, flash across front pages, meteor-like, and are gone. Horrendous though the sporadic crimes of these may be, and are at times, they do not compare with those of the so-called "big shots" and their "business" organizations that exact a toll of billions of dollars annually from the country. Lurid notoriety, built for the cheap thugs and hoodlums by sensation-mongering newspaper editors who pander to the morbid emotionalism of moronic masses, tends to make us forget the wolf tearing at our vitals.

Splendid it is when federal agents track down and kill the meteoric ones but let's glorify none by calling him bandit or public enemy No. 1; let's heap well-deserved abuse upon them all, call them cowardly rats (since their courage lies solely in the tommy-guns they use), give them a few public, and therefore degrading—to them—floggings. This done, let us go after the one who does his work in less spectacular fashion, quietly but efficiently, through bribery and corruption of public officials, and through the trickery of clever shysters. Legal loopholes made use of by these leeches who hold themselves above the law must be stopped, payment of further tribute to them must cease, and a concerted effort must be made by state and federal forces to put them where we all know they belong. Public opinion, aroused and co-operating fearlessly with peace officers, will aid tremendously in stemming the advancing tide of crime, but it *must* be aroused to fighting pitch.

If the police "West Point" can be established, a splendid beginning will have been made. There, police of all ranks will not only be schooled in the use of guns and crime detection instruments but will also be given sufficient legal knowledge to aid them in carrying on a crime war and to combat political influence. Needless to say, powerful "interests" will fight establishment of such a scientific school, but it is to be hoped that here public opinion, seeing the light, will prevail. It is time to lift ourselves out of the mud!

Naughty Babies

IN this world there are people—many of them, we fear—who actually do not want to know the truth if it runs contrary to their pet emotions. "So much the worse, then, for the fact," said someone whose belief was shown to be contrary to fact.

Such a mentality have those at present in power in Germany, with their Aryan superiority dogma, a political faith disguised as a scientific theory. Here is the latest bit of "plastic surgery" on a mere fact which has emanated from that land: As ethnographers know, the predominant head shape in Germany is broad and flat. But the Nordic origin of German nationality calls for a Nordic head—long, narrow. What to do?

The Nazis are equal to it. It is now argued that the broad heads come merely from the habit of placing babies on their backs; as if the children of German-Americans, who sleep in American posture—that is, where they wish—were not also broad-headed to the same extent as in Germany.

Here is a suggestion for the Nazi regime: Make it *verboten* for any German baby to sleep on its back. Throw naughty German babies caught sleeping non-Nordic into concentration camps. In one generation, on the theory mentioned, the German nation would then become truly Nordic, a great victory of politics over science.

What the German leaders and their pseudo-scientist supporters most need at present is a simple sense of humor.

RADIO FACSIMILE

May Add Sight to Sound Broadcasting

By C. W. PAGE

IN the radio broadcast studio of the near future the operator will place a picture and a piece of printed matter in the rack of a machine. On this will be focused a tiny light beam, which will be reflected to a photo-electric cell or "eye." The "eye" and the light beam will start to move, and in thousands of home radio sets a "radio-pen" will glide back and forth in unison with the beam of light at the transmitter.

Out of the home set will slide a strip of paper similar to ticker tape, but much wider. It will contain, let us say, a news bulletin on the result of a final international yacht race, with a cleancut picture of the winning yacht crossing the finish line. In other words, the home radio set will produce a copy of the printed material that was fed into the broadcasting machine, with picture and text reproduced in facsimile by the tracery of the automatic pen.

That is what facsimile radio has in store. Authorities declare that facsimile transmission is no longer in the experimental stage, but is a proved practical success that only awaits commercial development to place the "home radio printing press," as it has been called, in homes throughout the country.

THE creators of facsimile radio believe it will prove invaluable as an adjunct of sound broadcasting, by supplementing the audible program with illustrations and written notes, or making permanent records of useful data. Facsimile reproduces drawn illustrations, any type matter or lettering, newspaper articles, music manuscript, maps, diagrams, and so on. Program records for preservation would take such shape as illustrations to clarify oral statements, or printed notes on a musical performance. Recipes could be printed in connection with a food manufacturer's broadcast and save listeners the trouble of finding pencil and paper and writing from the speaker's dictation. Reply coupons would be printed for writing to broadcasters or for voting on program popularity, thus indicating station coverage. Programs of future broadcasts would be presented, together with printed quotations, weather reports, and so forth, which are easily confused if only spoken.

Sounds uncanny, this visual reproduction job of the newly invented radio facsimile, but it is only one of the latest trends of radio science as developed by

John V. L. Hogan, inventor of the "radio-pen," examining a strip of drawings to be transmitted. Note the scanner

John V. L. Hogan. Mr. Hogan indicates that the high price bugbear, one of the factors to delay the arrival of television, will not hinder facsimile. He estimates that facsimile reproducers can be manufactured to retail for 50 dollars or less. These will be in the shape of a compact cabinet, about the size of a portable typewriter, to be coupled with the ordinary home radio receiver so that reception can be switched from loudspeaker to facsimile and back again as desired. On the other hand, the reproducing device, which is described roughly as the equivalent of a loudspeaker unit and auxiliary connecting mechanism, can be incorporated in new radio sets at the factory. Facsimile is said to be perfectly simple to operate and to require a minimum of attention.

Under present conditions, sound and facsimile cannot be received at the same time through a set, but this is said to be a temporary situation, due to the fact that, as yet, few exclusive air channels have been allocated to facsimile. As soon as more channels are opened up, simultaneous synchronized broadcasts and reception of sound and facsimile will become possible. It might be said here, in passing, that experiments now being made in the 1500 to 1600 kilocycle wave band may lead to the assignment of this division to facsimile exclusively.

The broadcasting station's installation for facsimile transmission need not be very costly. A regular sound transmitter is used, a scanning device employing a moving spot of light and a photocell being substituted for the microphone. The original pictures and text matter on a strip of white paper are fed under the scanner. The electric controlling "eye," moving from side to side, scans the copy as it passes slowly beneath.

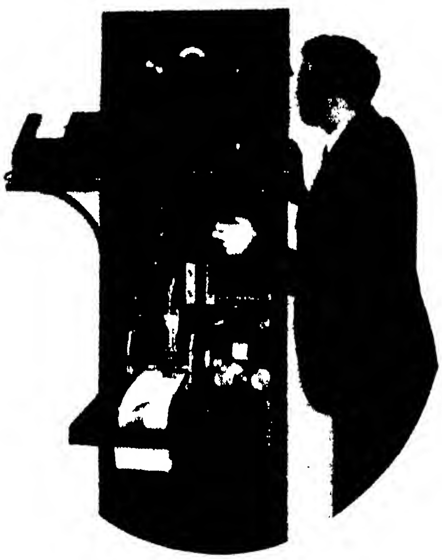
THE receiving set has, instead of a scanning disc, a sliding arm, which carries an electro-magnetic stylus. Each time the "eye" of the transmitter passes a black spot in the copy it releases a signal, which causes the stylus of the receiver to drop to the paper and make a mark, and to be lifted when the "eye" passes over a white space. Recent experiments have been along the lines of chemically treated paper which changes color when acted upon by the "radio-pen." Synchronized motor mechanisms move the transmitter eye and receiver stylus across the paper, and, at the end of each line, advance the paper to the next line of scanning.

The printing paper strip of the present type of experimental receiver is seven inches wide, in roll form, and feeds into the receiver in adding machine style. It threads upward under the tracing mechanism and then out of the machine like ticker tape. The machine's reproduction of picture and text is performed in full view.

The facsimile broadcast transmitter

does not require as wide an air channel as sound. A six-kilocycle band is sufficient. At present stations W2XAR, Long Island City, and WTMJ, Milwaukee, are sending out facsimile, and have been doing so, experimentally, for almost a year. It seems very likely that other stations will soon qualify and the combination of sound and sight broadcasting is expected to develop into radio's peak achievement to date.

Having presented some of the things which facsimile may be expected to do,



One of the transmitter panels, showing the facsimile mechanism near the bottom

let's consider what it will *not* do. This seems to center mainly around its speed limitations. The seven-inch printing paper moves at a speed of 1¾ linear inches per minute, resulting in a text word speed of from 30 to 60 words, with an average of about 40 words per minute. Transmission is faster when the material is limited to printed text than when illustrations are included. A sound program can carry four or more times as much information in the same time, but on a synchronized broadcast, facsimile can keep up by being confined to essential notes, memoranda, and pictures. It is thought that its value in explaining the sound program will prove one of its strongest features.

It has been stated that facsimile might go so far as to print a complete newspaper. If this should become possible, radio owners would switch to facsimile on retiring and find in the morning a complete, home printed newspaper with last-minute news flashes as late as they cared to continue operation.

In support of the idea, it might be cited that, so far as late flashes are concerned, this might be a valuable service. Morning papers go to press for the first time anywhere from 7:30 P.M. of the night before to midnight. By shortly after 1 A.M. the newspaper is set. That

The Radio "Printing Press" . . . Only Awaits Commercial Development . . . Transmits Anything Written or Drawn . . . Will it Replace Newspapers?

is to say, changes after that time are chiefly mechanical, a matter of polishing and improving the product. It would take a news story of considerable importance to make any radical change in the paper after that time.

Most newspapers, however, keep their front pages open until three or four o'clock in the morning for last-minute news. The final edition is then distributed mainly in the downtown districts of large cities. The suburban, rural, and mail readers get much earlier editions. Thus facsimile, flashing late developments on happenings between midnight and seven or eight o'clock in the morning, could supply a valuable service, at least to these last-mentioned groups.

On the opposite side of the ledger are both the slowness of the facsimile method—it would take a minimum of three hours to reproduce a single newspaper page of normal size—and the form in which it would come into the home. The facsimile receiving set prints its text matter in type a quarter-inch high in columns five inches wide on a seven-inch strip of paper. This means that three lines of words, with the spaces between, would fill about a lineal inch of the paper. Thus the news would be presented on an endless roll of paper, folded bulkily in a basket or other receptacle. Because the presentation of the news must be chronological, it would not be possible to sort items of interest as on the regular newspaper page. One would have to read through the entire scroll to get a digest of the night's happenings.

Finally, operation of the machine would cost at the rate of about one cent an hour for electric current, plus the cost of the printing paper, and it would still be necessary to invest in the regular morning paper to get a complete news report.

It is not possible to forecast what the future may bring in increased printing speed, size, and presentation of the printed sheet, but for the present, it seems safe to regard facsimile as a possible supplement of the daily newspaper for presenting flashes, spot items, and highlights of the day's happenings, referring readers to their daily papers for full particulars.

This is just about the news job that sound radio is doing now, but there would be this difference: Facsimile would "work while you sleep," or while you were occupied with other matters, and still deliver the high spots of the news. Besides, it would give a printed record and not leave you dependent on memory of what was heard.

Whether or not one believes in facsimile as an agency for news dissemination, there seems no doubt that it is soon to be very much with us for a considerable stay. Its rating for service to the public and commercial value to broadcaster and advertiser will depend upon its development and acceptance by those most vitally concerned.

A facsimile receiver coupled to an ordinary type of home radio set

Building the World's

DEEPEST-WATER BRIDGE

By WALTER G. SWANSON
Administrative Assistant, San Francisco-Oakland Bay Bridge

Double-Decked . . . 8¼ Miles Long . . . In Two Sections . . . Twin Suspension Spans In One Section . . . Will Serve Huge Industrial Centers

LARGER than any like construction project ever undertaken by man, the San Francisco-Oakland Bay bridge is being speeded to completion. When at last the 45,000,000 persons and 5,000,000 automobiles transported each year by ferries between San Francisco and Alameda counties begin to move across the structure they will enjoy the distinction of riding over the world's longest and highest above-water bridge, supported by piers sunk deeper than any heretofore poured under water.

The bridge primarily will connect San Francisco, where six square miles at the northerly tip of a peninsula support a population of 635,000 people, and the "East Bay" district, comprised of Oakland, Alameda, and Berkeley, totaling in population 393,000. Each day 50,000 commuters cross from these communities to San Francisco.

When completed, the bridge will supplant the present system of ferries and measurably speed up traffic. It is being constructed by the California Toll Bridge Authority as a state enterprise at a cost of 77,200,000 dollars, after a commission appointed in 1929 reported its economic feasibility and recommended the design which, with modifications, is now being followed. Construction started July 9, 1933, when President Roosevelt touched off by telegraph a blast which broke ground for the Yerba Buena island section of the work. The bridge will be completed by August, 1936, when the State of California expects to open the structure to the public.

Of particular interest physically, the bridge will be double-decked, with roadways 58 feet wide. Its length will total 8¼ miles, including approaches. From Rincon Hill, San Francisco, it will extend in a northeasterly direction to Yerba Buena island, bridging a 10,450-foot expanse with twin suspension spans. This island is an irregular outcropping of sandstone midway between San Francisco and Oakland and rises 340 feet above the water. It is 3000 feet wide and is occupied jointly by the Army, Navy, and lighthouse services.

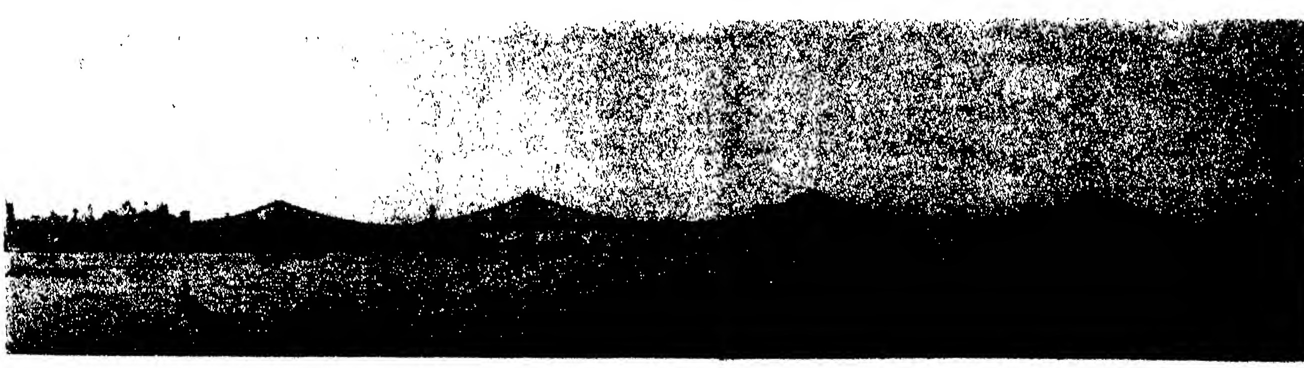
EACH of the twin suspension bridges comprising the West Bay section will consist of a main span of 2310 feet with side spans of 1160 feet. These suspension bridges will clear the water by 180 to 214 feet, more than adequate to permit passage of the largest vessels. Traffic will cross Yerba Buena island through a steel- and concrete-lined tunnel. From Yerba Buena the bridge curves to the right, then follows a line almost due east to Alameda county. The cantilever-type span over the shipping lane is 1400 feet long, clears the water by 185 feet, and is exceeded in length only by the Firth of Forth and Quebec bridges.*

The underwater portion of the bridge, a feat which has attracted international engineering attention, has now been completed, and another of the "big jobs" has passed into history. That part which lies underwater consists of 51 concrete piers. Of these, 8 are ordinary concrete columns built on land; 17 are ordinary concrete rectangular and cylindrical structures set over fir piles which brought the bridge down to a sand fill in the tidelands northeast of Oakland; the remaining 26 concrete piers are all major units in the substructure of the bridge. Of these, eight break previous records for depth of concrete submarine construction.

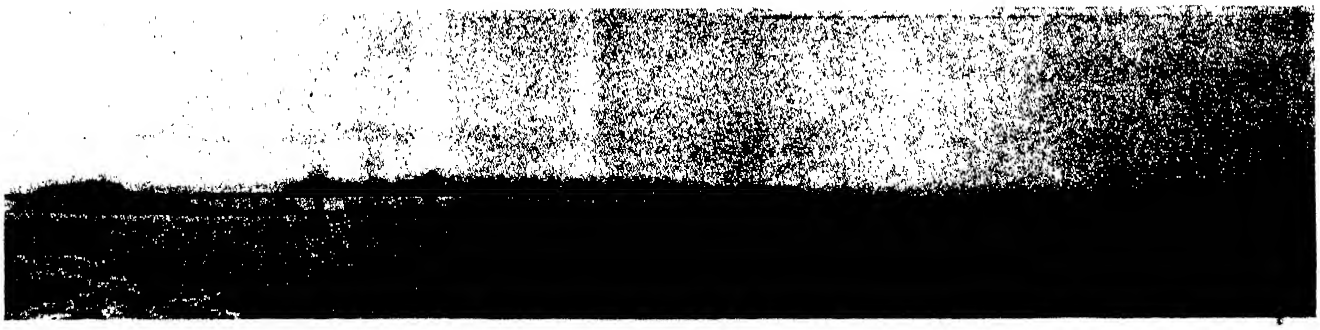
At this writing, after 17 months of work, the bridge construction has metamorphosed from the substructure to the superstructure stage, with all its concrete underwater jobs completed, and six of the 288-foot double deck truss spans, at the east end of the bridge, erected. Three of the four 500-foot structural steel suspension towers, which will support the two 28¾-inch parallel steel wire cables over the West Bay crossing, have been erected, and the fourth tower will soon be on its way to completion.

The superstructure does not set any bridge building records except that it is an 8¼-mile bridge, 4½ miles of which is over water, and will bear the huge weight of two decks of automobile, heavy truck and electric railway traffic, with complicated tentacle-like ramps curving off the 185-foot elevation of the decks to the street levels at the west end, and an equally complicated and carefully engineered elevated structure sending traf-

*For a comparison of "largest" bridges, see page 141, March 1934, *Scientific American*.



The West Bay section, from San Francisco to Yerba Buena island



The section of the bridge from Yerba Buena to the "East Bay" district

fic in three directions at the eastern end.

The superstructure involves the construction of concrete arch trestles and a set of twin suspension bridges over the two-mile West Bay channel, with a common concrete monument for a central anchorage in the middle of this two-mile crossing, which is new to bridge building. Also, the East Bay has a variety of bridge types embracing the 1400-foot double-deck cantilever span, five 500-foot through truss (railroad type) bridge spans, and fourteen 288-foot deck truss spans which come to a fork at the east end of the bridge where the lower deck divides to permit the upper deck to go down between the two forks of the lower deck.

The deep-water piers, like underwater buildings of concrete and steel erected upside down in floating caissons by the same highly successful gamblers of construction who are building Boulder Dam, lend something more than mere bigness to the job. Piers W-3, W-4, W-5, and W-6 of the deep water of the West Bay channel, which support the towers and center anchorage of the twin suspension bridges, were constructed within open-dredging-well caissons, modified to permit flotation by compressed air. The resulting caisson, designed by Daniel E. Moran and Chief Engineer Purcell and his staff, is an important addition to subaqueous engineering. The largest caisson of this type is that of Pier W-4, the concrete center anchorage.

A drawing, looking from one of the suspension towers to the tunnel portal on the island

THE completed concrete pier will be a rectangular structure 220 feet high from bedrock to water surface and, roughly, 200 feet wide by 100 feet thick. This concrete structure is cellular, or honeycombed. Piercing the concrete block are 55 vertical holes, each 15 feet in diameter—the size of a large circular room. The walls around these 15-foot vertical cores are of concrete, reinforced with a network of steel. The cores are hollow and the pier is open at the sides to permit sea water to flow into the 15-foot wells.

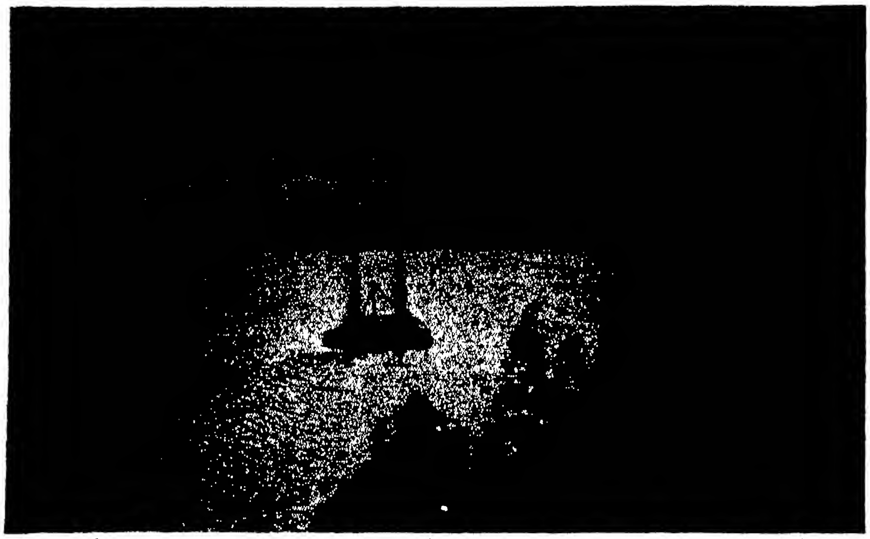
The 15-foot dredging wells at Pier W-4, the center anchorage of the long suspension spans

In all other piers, save this anchorage pier, all cores are hollow, but in Pier W-4 three of the 15-foot wells at each corner, or a total of 12, were filled with concrete from bottom to top as the structure was being completed. For the first 40 feet of this pier at bedrock the structure is solid concrete, a seal of concrete having been poured upon the rock 10 feet below the bottom of the caisson and up each well 30 feet. Like a non-tipping smokers' stand, the pier is weighted solid at the bottom.

To build this structure in water 80 feet deep, with a six-mile-an-hour tide, the novel compressed-air flotation caisson was designed. The outer walls of this caisson are of plate steel for some 17 feet up from the bottom or cutting edge which is beveled on the inside to facilitate sinking through mud. Above the plate steel the walls are of timber caulked water tight. Inside this rectangular floating structure, box girders divide the first 17 feet at the bottom into 55 square cells. Over these square cells are transition cones, or adaptor sections, like steel collars, to which are welded 15-foot steel pipes. At the tops of these pipes, plate steel hemispheroid domes are welded. On each dome is a pressure gage and a valve for compressed air hoses. Thus the caisson consists of an outer wall around a cluster of 55 vertical tubes, domed at the top (during the floating stage), and open to the sea water at the bottom.

HELD at the site by concrete anchors on four sides, this caisson was sunk by the simple process of pouring concrete into it around the 55 steel tubes. When concrete had been poured almost to the top of the tubes, a portion of them were heightened by cutting off the dome and welding on a 20-foot section of pipe, and then re-welding on the dome while other pipes were being similarly treated until the height of the outer walls and the steel tubes within were all increased so that another pour of concrete could be placed within the structure to sink it still farther into the water.

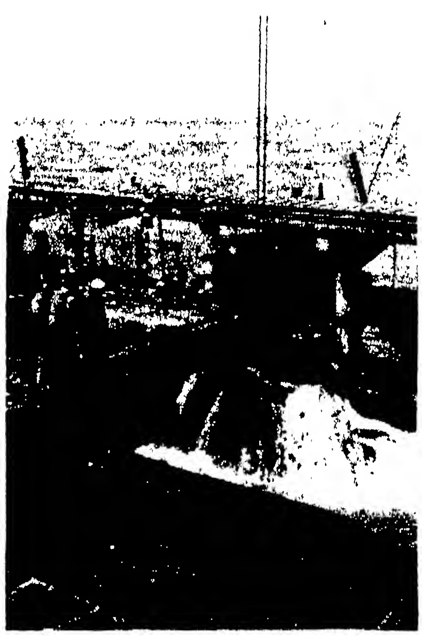
When the caisson's cutting edge lay



Completed towers W-2 and W-3 in the background, with the San Francisco skyline. View from Yerba Buena, with partially completed Pier W-6 near the center

within two or three feet of the mud, the air was reduced within all the tubes and the caisson dropped suddenly into the mud. When solid, the domes were removed. Then clam-shell buckets were lowered down the open wells to the mud beneath the caisson. These buckets undermined the mud beneath the rectangular structure, permitting it to sink by its own weight to within 10 feet of bedrock, where it was stopped and the bedrock cleaned off for the concrete seal floor laid on the rock beneath the caisson.

No men worked under air pressure below water on any of the piers on this bridge. Sand-hogs were eliminated by the clam-shell buckets. Pier W-4 cost approximately 3,000,000 dollars and contains 200,000 cubic yards of concrete, which is more than enough to complete the construction of an Empire State building.



Final cleaning operations on one of the caissons. Clam-shell buckets replaced "sand-hogs" on this job

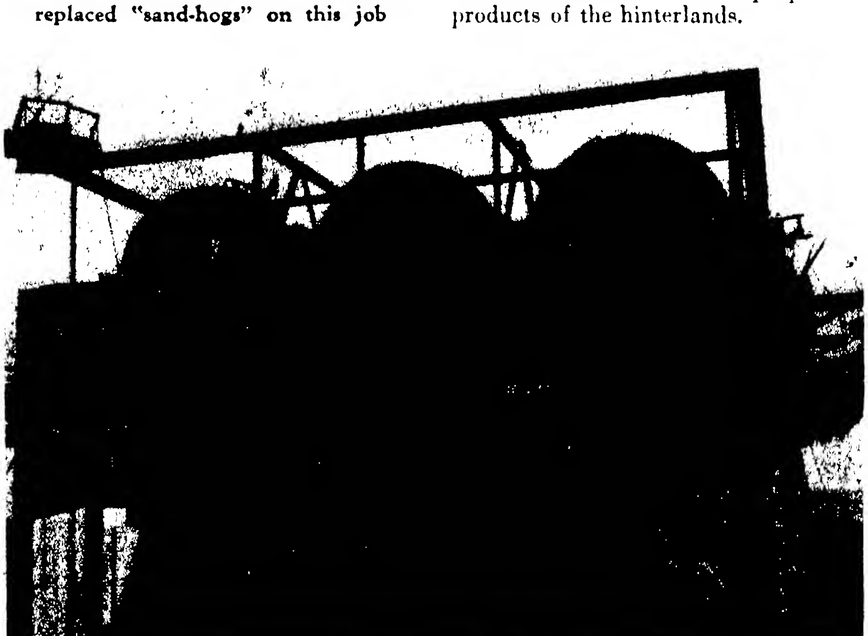
THE false-bottom open-dredging-well caissons are similar except that the cells are square rather than circular, and flotation during the first stage was obtained by timbering over the square wells at the bottom of the caisson to keep the water out and maintain buoyancy. When these caissons landed on the mud, the timbers were jerked out of each of the wells, which produced the same result as cutting off the domes at the top of the compressed-air-flotation caissons.

Other underwater concrete piers of the bridge were built within steel sheet piling cofferdams, like stockades, or plate steel tongue-and-groove pilings. These piles were driven deep into the mud and the mud excavated from the rectangular space within. On most of the piers built by this method some 300 timber piles were driven into the sand-clay strata, and the concrete pier built within the cofferdam and on top of the butts of these piles. This was used where rock in the East Bay tidelands was beyond reach of practicable engineering construction (some 500 feet below sea level).

The superstructure involved a 20,000,000-dollar United States Steel Company order, said to be the largest ever placed. This order involves the entire steel work on the bridge—the spans, the steel towers, the suspension cables, suspender ropes, the cantilever steel, the other truss spans, and the deck truss spans, six of which have already been erected at the time of writing.

By January 1, 1935, all the substructure contractors, many of whom are involved in Boulder Dam construction through the Six Companies, had sold their 1,500,000 dollars' worth of equipment and moved away from the job. Superstructure work has overlapped during the last half of 1934 and will be in full possession of the field in 1935 and to the date of completion. Spinning of the 17,464 parallel-wire cables of the twin suspension bridges between San Francisco and Yerba Buena island will be started by the time this article is in print. The East Bay spans are well under way and will be half completed by the middle of 1935. The huge vehicular tunnel, 76 by 58 feet, through Yerba Buena island, is now half completed by hard rock miners drilling and blasting. This tunnel, which is claimed to be the world's largest bore, would permit a four-story building to be towed through it upright, were it not for the double-deck construction.

AS pointed out earlier, the bridge will link two important communities. Economically it will do more, for it will bring closer together in time and cost San Francisco's financial, business, industrial, and shipping centers; the East Bay's ship yards, rail and water facilities, and factories; and the people and products of the hinterlands.



One of the caissons, showing the welded steel-plate domes

‘Canned’ Roses

By HERBERT O. WARREN

Cutting rose bush stems to the proper length for waxing

Left: Dipping the stems of rose bushes in wax that has been melted in a special electrically heated tank. *Below:* Placing the processed bushes in boxes

Below: The roots of the bushes are wrapped in moss

Right: The bushes as they are delivered to the buyer. The wax on the stems falls off after bushes are planted

Below: If the processed bushes are properly planted, and given reasonable care, they will produce roses rivaling those grown in their native soil

WHEN Mrs. Jones shops in the Main Street Department Store, an array of packaged goods greets her eyes. Packaged shirts and hosiery, Cellophane-enclosed commodities in great number—and now, “canned” roses. She also has her choice of variety, size, color, and fragrance, for packaged roses are making their way into every city and hamlet in the United States. A large California nursery, the Leonard Coates Company, located close to San Jose, is growing, processing, and shipping rose bushes, which, attractively packaged, are finding good demand throughout the country.

Other nurseries are contemplating entering this lucrative field with large-scale production and distribution, as a result of the development of special processes for preserving rose bushes. Dozens of varieties of roses are being marketed by the San Jose nursery, all of which can be purchased over the counters of eastern stores. And this is the direct result of observation on the part of some enterprising nurseryman, who remembered his childhood days when he watched his mother pour hot wax over fruit in glass preserving jars.

The full-fledged idea was not born overnight, however, for growers had long experimented in the endeavor to find some method of preserving plants.

In the new process, the rose bush is first pruned to the proper size to fit a standard container. That portion of the box which is to contain the roots is coated with tar, so that moisture can be retained. Applied at a temperature of from 165 to 180 degrees, and with a sufficiently thin coating, ordinary paraffin can preserve an entire season’s growth of choice roses. Much experimentation was required to find the proper temperature. When too hot, the melted wax burned the tissues, and curtailed the plant’s growth after planting. If the wax was not sufficiently hot, the coat cooled and flaked off in large bits. In order to keep the paraffin at a constant temperature, a double boiler-type vat, electrically heated, has been devised, in which an automatic thermostat controls the temperature. The plants are dipped quickly into the melted paraffin and as the cutting is withdrawn, the excess wax is shaken off. The hot paraffin does not come in contact with the roots, which are wrapped in wet peat moss.

ATTRACTIVE boxes have greatly assisted the sale of “canned” roses. Each bears a colorful reproduction of the plant it contains.

The amazing growth of the “canned” rose business is but the forerunner of an industry that promises to expand in the near future and include scores of rare and delicate flowers, not possible to ship long distances today. When that day comes, plants and flowers will be available for transplanting in localities far removed from their native soil.

A Star Swells Up

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE closing weeks of 1934 were the most interesting of the year to astronomers, for they were marked by the appearance of a conspicuous nova, or temporary star. This was first seen as an object of the third magnitude on December 14th, by an English amateur astronomer, Mr. Prentice, a lawyer.

His discovery, communicated to the Greenwich Observatory, was broadcast by the daily press, as well as by the usual astronomical cable service, and observers everywhere have been busy since. The nova is in the northeastern part of the constellation Hercules, about 10 degrees northwest of the bright star Vega, between it and the head of Draco. Within a few days after discovery it was in conjunction with the sun but, being about 68 degrees north of the ecliptic, it was easily visible, both in the evening after sunset and again before sunrise. For observers in northern Europe it is circumpolar and can be seen all night, though too low near midnight to be profitably observed.

It has varied in brightness more slowly, up to the date of writing (January 5), than typical stars like Nova Persei or Nova Aquilae. For about a week after its discovery it rose gradually and at maximum, shortly before Christmas, it was of magnitude 1.5, equal to Alpha Cygni—though not to Vega—and one of the most conspicuous stars in the heavens. Since then it has declined, but this evening it was still only a little fainter than the second magnitude. Like other bright novae it has fluctuated by more than a magnitude, but the general downward trend has been very gradual, resembling Nova Pictoris rather than the stars more familiar to northern observers. Its present position in the sky is favorable for the study of these changes for, combining evening and morning observation in Europe and in America, there would be no interval of more than four hours length when—weather permitting—the star cannot be followed.

IT was far west at the time of the outburst and outside the part of the sky habitually covered by the nightly "Harvard patrol" with wide angle cameras. The latest photographic record of the region so far reported was on October 4th, and showed the nova as a star of magnitude 14.5. On November 14th it was fainter than $13^{m}8$. It increased by 13 magnitudes, or to 160,000 times its original brightness, within a month and probably in much less time.

Like the other bright novae of this century it was not discovered by a professional astronomer but by an amateur. The reason is fairly obvious. The professional observer is usually busy with some definite program. He must set his telescope and study some particular object, whether he be observing double stars or measuring some variable with the photometer, or photographing spectra or perhaps fields rich in nebulae. He is not likely to spend much time in gazing about the heavens at large. The amateur, especially if he is not too much encumbered with a telescope, has time to watch the skies. If he has a good enough memory to remember the constellations, and takes the trouble to become familiar with them, and if he has the patience to go over the sky night after night despite the monotony of seeing the very same stars over and over a thousand times, he may some day put his name permanently with the record, and what is more, enrich science with an opportunity which would otherwise be irrevocably lost.

SINCE the 20th Century began, five prominent novae have been seen. Nova Persei in 1901 reached the magnitude 0.1; Nova Aquilae (1918) $-1^{m}1$; Nova Cygni (1920) $1^{m}8$; Nova Pictoris (1925) $1^{m}2$; and now Nova Herculis, $1^{m}5$. Nova Geminorum (1912) reached $3^{m}7$ and Nova Lacertae (1910) rose to $5^{m}0$ (as shown by photographs taken before its discovery).

The last two would probably have been missed by the casual observer, but the five others were conspicuous at a glance to anyone familiar with the constellations.

Only three bright novae were recorded in the second half of the 19th Century, and none in the first half. It may be that we have been favored during the last generation by an accidental accumulation of these outbursts, but to get five in less than 40 years by mere luck seems very improbable. The amateur astronomers of the last century were less numerous, not so well informed and, above all, not at all organized—few of them knowing where the announcement of a discovery might be sent—and this may account for a large part of the difficulty.

There is no such effective watch kept upon the fainter stars, and a great many novae which do not rise to naked eye visibility are doubtless missed. The late Professor Bailey of Harvard concluded that at least ten such objects brighter than the ninth magnitude at maximum must appear every year. Those which are near the sun in the sky when they flare up are naturally lost, and the watch on the southern heavens is much less vigilant than on the northern. But, after full allowance for this, it is probable that three or four novae could be caught each year if the cost could be met for a careful examination of the sky patrol plates as soon as they are made. There are, however, so many more urgent problems awaiting study that this can hardly be done at present.

THE present nova was naturally the object of much discussion at the recent meeting of the American Astronomical Society. Observations of its spectrum were reported from the Harvard, Michigan, Yerkes, Lowell, and Mount Wilson Observatories. It resembles other novae in showing wide, bright lines flanked with narrower dark components on the violet side, but the width of these broad emissions is much less than in Nova Persei or Nova Aquilae. Near the maxima of its subsidiary fluctuations in brightness the bright lines almost fade out, leaving a dark-line spectrum. Shortly after the discovery this spectrum closely resembled that of Alpha Cygni—a hot star of class A2. Later on, the metallic lines strengthened at the expense of the hydrogen lines and it was more like Gamma Cygni (Class F8). Both of these stars are well known "super-giants," very remote and of enormous luminosity. Comparisons of an ephemeral object like the nova with these unchanging stars are risky, but it is probable that the former, too, was of great real brightness when the light by which we now see it left its surface.

At the minima of the light fluctuations the bright bands were relatively stronger, but the dark absorption lines were still present.

AND BURSTS

Nova Herculis, the Recent New Star . . . 20,000 Times as Bright as the Sun . . . An Opportunity for Amateur Astronomers to Add to the Scientific Record

It is clear that this nova differs from its predecessors in details rather than in its general nature. The explanation which has now been generally accepted for the others accounts for it too. In the epigrammatic phrase of a German astronomer, "A star swells up and bursts." More precisely, it appears that suddenly an enormous liberation of energy takes place within the surface of a star. Its immediate effect is to drive the upper layers of the mass radially outward in all directions, so that the previously quiescent body is replaced by one which is expanding at a very rapid rate. At first this expanding shell of gas is thick enough and dense enough to be opaque. It is exposed on its inner side to powerful short-wave radiation from the intensely heated core of the star. This is absorbed in the shell, and heats it so that its outer surface maintains roughly the same temperature despite its rapid expansion. The amount of light which escapes from it into space therefore increases nearly in proportion to its area. When it has become 100 times as large as it was originally, it will be 10,000 times as bright when seen from interstellar distances, even though the light emitted per square mile has not changed.

BUT as the expanding shell spreads out laterally it must grow thinner—not necessarily or probably in miles, but in the quantity of material per square mile. The gas of which it is composed will become more and more rarefied, and sooner or later it will begin to become transparent. After this has happened the ultra-violet radiation from the hot core will escape directly into space.

An observer unhampered by air above him, and with a recording instrument which was equally sensitive to all wave-lengths, will probably find the star brighter than ever. But to us behind the ozone in the stratosphere, which cuts off all the shorter waves, the brightness would appear to decline. The expanding shell, though transparent in general, would still absorb all the kinds of light characteristic of its own composition, just as any stellar atmosphere does, and scatter the absorbed light in all directions in a bright line spectrum, like the flash spectrum seen at a total

Robert Albert Lewis, a Columbia, South Carolina, amateur telescope maker who discovered Nova Herculis independently

solar eclipse. The part of it which lies in front of the core will therefore absorb from its continuous spectrum a set of characteristic dark lines, but all these lines will be shifted toward the violet, since this part of the shell is approaching us. For the rest of the shell, which is moving sidewise, backward, or more slowly toward us, the bright lines emitted by the gas will be unshifted, displaced toward the red or a little to the violet. They will escape absorption and appear in our spectrograms as a broad, bright band, centered on the usual position of the line, extending both to the red and the violet but cut off on the violet side of the band by the absorption line already mentioned.

This is the stage in which Nova Herculis is at present, or was at least when its spectrum was recently photographed. The earlier stage, in which no bright lines appear, but only a dark-line spectrum shifted toward the violet by the approach of the expanding surface of the opaque shell, was observed in Nova Geminorum, but must have been missed in the present case.

The transition from opacity to transparency of the shell is of course not instantaneous, and various phases omitted here for the sake of simplicity may be recognized when the changes in the spectrum have been thoroughly studied. As the shell expands still farther, and the gas becomes still more rarefied, it passes gradually from the physical state of a stellar atmosphere into that of a nebula.

THE energy to keep it shining comes from the core of the star—which evidently still contains most of the original mass. This survives the outburst, but settles into a very hot body possessing a spectrum of the Wolf-Rayet type, with bright bands which suggest that it is still expelling atoms from its surface, though with less violence.

At last the shell expands so much, and becomes so thin, that its light fades away and the drama is at an end. The difference between Nova Herculis and such characteristic objects as Nova Persei or Nova Aquilae appears to be mainly that the velocity of expansion is much slower—something like 200 kilometers per second as against 1700 for Nova Aquilae.

The slow rise to maximum is easy to understand. If the gaseous shell itself is comparable with that in the other novae, it ought to take six or eight times longer to reach any given stage of its history. This is of course but the roughest of estimates; nevertheless it seems probable that Nova Herculis will remain bright for a relatively long time and afford an unequalled opportunity for study.

How far off it is, and how bright, we do not yet know. When and if the expanding shell gets large enough to be seen as a small nebula with powerful telescopes we should obtain a very good estimate of its distance, such as we have for Nova Aquilae and Nova Persei. Meanwhile Dr. Struve has made a rough estimate of its distance from the intensity of the K line of calcium (which, in this as in many other cases, appears to be produced by scattered atoms in interstellar space), and concludes that it is of the order of 1500 light-years. This would make its maximum brightness 20,000 times that of the sun. But we must wait for future data before we can be sure.—*Princeton University Observatory.*

PACKAGING IN INDUSTRY

HOW IS IT WRAPPED?

Packaging Now an Industry . . . Amazing Growth . . . Follows Trend Toward Color, Originality, Modernity . . . Employs Much Talent . . . Enhances Quality or Appearance . . . Phenomenal Profit Increases

By PHILIP H. SMITH

INDUSTRY is making huge outlays to promote the art of packaging. And for very good reasons. Skilful packaging has been found to quicken the sale of products to a phenomenal degree; it opens the way to substantial economies in the shipment of goods: and it is instrumental in reducing losses incurred by deterioration and spoilage of consumer articles.

Packaging is a bewildering business. It involves an array of materials such as wood, paper and paper products, metals, glass, rubber, plastics and other synthetic materials. It utilizes the skill of sales promoters, industrial designers, draftsmen, research chemists, machinery manufacturers, not to mention all the allied workers such as the producers of inks, adhesives, and the materials from which packaging materials are made. And just to add to the bewilderment: every product packaged raises its own individual problem of design, material, and technique.

Here is an industrial enterprise without the status of an industry, yet within a very few years it has come to have an individuality of its own. Packaging once meant little more than wrapping products because they had to be wrapped to be moved, or at best, to carry the trade-mark of brand quality; today that is a very small though fundamental part of it. The cardboard, paper, and string stage is outgrown, and major credit for it must go to Cellophane, for it was this transparent material which made the consuming public "package conscious" in a new sense and gave impetus to the whole packaging idea.

IS it any wonder that business turns its attention to packaging when, for example, a group of grocery stores can increase the sale of dried-beans 29 percent, or noodles 80 percent, by the simple process of placing them in transparent bags? These are common examples of the benefits of packaging, but they tell only part of the story. To understand the significance of present-day packaging and to grasp the direction of its triumphant sweep, one must first become familiar with current practice in all its phases for it is the things being done right now which explain "why" and give an inkling of what is in store as this new industry progresses.

Practically all packaging aims to enhance quality or appearance, either of the package or the contents. This is true no matter what other purpose may be sought. Under this spur almost all household goods have passed or are passing through a re-juvenating process. Form, material, color, and treatment of packages have been altered to attract attention, to make them stand forth and encourage the consumer to say "Give me that." Indicative of the wide variety of packaging for appearance are: bags of kraft paper simulating leather, for carrying whiskey bottles; transparent wraps for coffee cans; bottles made to look like a honey comb, for strained honey; glass milk bottles with colored imprint; plastic boxes for a variety of goods; wood-grain paper coverings for cosmetic boxes. Packaged rugs and shirts, sheets and blankets

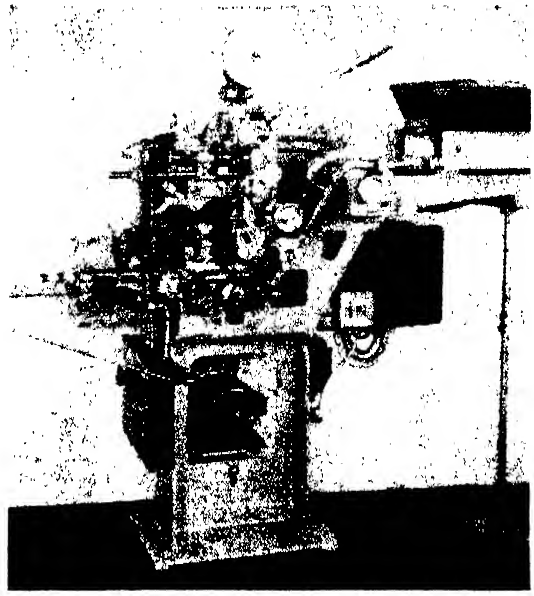
in cellulose wrappings express the aim of better appearance with the added purpose of keeping the articles clean.

Accompanying efforts to make packages more attractive have been those of making them more convenient. A tack manufacturer, for example, has redesigned his package to permit picking out a tack without pricking the finger or tipping the box over; ink makers have been widening bottle-mouths for easier filling of pens; while a pencil company puts its lead re-fills in a paper pack like matches. And products theretofore not packaged are now being placed in containers to facilitate the use and handling of the product. One coal company offers cannel and stoker nut coal in 50-pound corrugated boxes; another puts anthracite in 18-, 25-, and 50-pound bags. Packaged lumber is on the market, so is beer — in cans with keg lining. Even lubricating grease has been packaged in cartridge form with special equipment for use. Such examples can be multiplied indefinitely, but there is still another type of packaging which is more striking. This is the type which features use of the package itself when the contents have been consumed. It is another twig of the vast packaging tree, but perhaps the fastest growing.

RE-USABLE containers have made great strides since pottery ginger jars from the Orient served as flower pots. Malted milk comes in colored glass jars with screw tops, handy in a number of ways; tea, cheese, and jams are packed in thin-blown tumblers, suitable for the table; a pair of garters and suspenders come in a leather container which becomes a book cover; while a belt in a plastic box provides a humidor when the belt is removed. As evidence of ingenuity, witness the container for a belt which makes a cocktail shaker when placed over a drinking glass, or the variety of re-usables launched by a west coast company. This particular concern packaged vinegar in a bottle which was suitable for ice water and when the market seemed well sold, it switched to a bottle that would make an attractive lamp base, to be colored if desired. Then, sales soon doubling with this practice, table syrup was offered in a would-be candlestick jug.

The foregoing examples of packaging represent the most obvious and the best understood. There is still another type, and it is a highly significant one—packaging to prevent or retard spoilage of food products. It has been given comprehensive study but as a research matter it is still in its infancy. It ties in closely with the transparent cellulose development and for that reason we must discuss it first.

Cellophane was a laboratory product and the self-starter of the packaging engine. Its first large scale application—to cigarette packages—is familiar to all. And the reason for this was its moisture-retaining quality, as well as its neat appearance. Cellophane raised many problems. It wouldn't stick, it wouldn't take printing, and it didn't lend itself to existing wrapping machinery. So technicians had to take hold, develop adhesives and new printing processes, and redesign machinery. And while they were doing this, competing products came on the market—Sylphrap; Protectoid and Kodapak, both cellulose acetate products; and, more recently, Pliofilm, a synthetic rubber. All of these products have their peculiar qualities; some are more moisture proof than others; and they vary in tensile strength and other characteristics. Sylphrap, for example, has one type for which is claimed practical impermeability to invisible ultraviolet rays without sacrifice of transparency, while Pliofilm claims, among other qualities, resistance to oils, greases, and many chemicals.

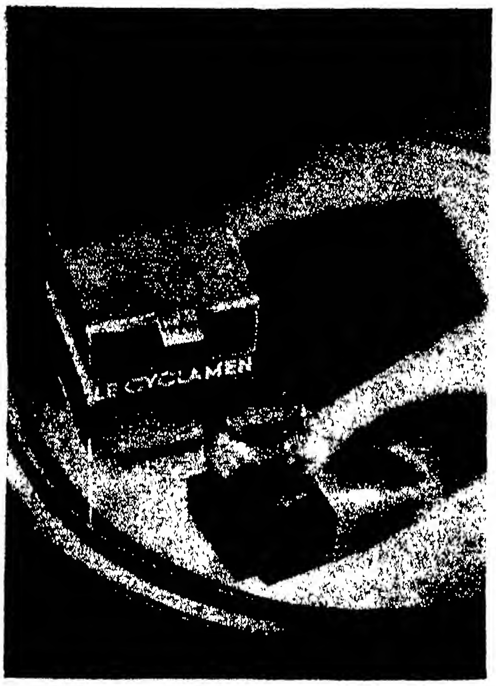

To wrap coated gum tablets in printed Cellophane, while a photo-electric cell supervises


Pioneer suspender box and re-use container. The molded plastic box becomes a humidor

The transparent cellulose films have stimulated many other developments and we find in the packaging world such accomplishments as cellulose acetate containers, made like cans, with transparent sides and metal top and bottom, rugged and capable of re-use. We also find a product which when applied wet to the tops of bottles, shrinks and forms a tight seal. All these developments stemming from the application of cellulose to packaging, represent laborious research, but they by no means circumscribe the contribution of research as we can demonstrate by reference to actual cases, having the development of transparent cellulose in the background.

If many of us have heard of frozen foods—perishables frozen at sub-zero temperatures and shipped in this state to retailers for distribution—few have heard of the problems of packaging involved. Success of this enterprise hinged largely on proper containers without which there could be no wide distribution. What was needed was a container that would withstand conditions incidental to the freezing process and remain unaffected by the liquid or moisture within the package prior to freezing. It had to be essentially airtight. The problem was answered by a paperboard carton with a fixed inner lining of transparent, waterproof cellulose. Then for shipping these cartons with maximum protection there was developed a corrugated board container with a layer of asphalt barrier board, the corrugations giving strength and insulation, while the asphalt protects against the moisture of condensation.

THERE are vast possibilities in the shipping of chilled foods, and packaging developments have gone a long way toward making them a reality. It is now possible to ship foods using solid carbon dioxide—dry ice—as a refrigerant and exercise a high degree of control over temperature. It is done by using a paperboard box having a corrugated liner with imbedded aluminum or copper wires. One surface of the



"Upside-down" spherical perfume bottle on a plastic base—attractive packaging

refrigerant is exposed to this wire conductor liner which quickly spreads the cold to all parts of the container, while incoming heat is carried by the wires to the refrigerant. Further control is exercised by inserting corrugated resistance pads between the refrigerant and the liner.

In packing plants, in can and glass factories, in fact wherever food packaging is studied, technicians have made their contribution. So today we have dates pasteurized in the package to make them a year-around rather than a seasonal food. We have cans which allow cheese to be packed before ripening—a vent valve allows gases to escape while excluding entrance of air. And we have foods protected from bacterial growth by the process of packing in inert gasses.

FOR a long time it has been suspected that light rays had more to do with the deterioration of certain food products than was generally credited. The use of colored glass bottles in years past represents a rather unscientific attempt at meeting just this problem. Quite recently experiments conducted at the Department of Agriculture proved that light rays caused rancidity of butter: that grass-green is the best protective color and blue and violet the least. Even though this work is still in its preliminary stages it has begun to change packaging practice, and the upshot may be the saving of many millions in losses now incurred from rancidity. As a rancidity retardent metal foils have proved effective and the packaging of such products as potato chips in foil bags illustrates practice which is growing in favor.

Another manner in which research has played a rôle in packaging has been in lowering costs —reducing the mechanical costs of wrapping, lowering shipping weights by redesigning containers, and cutting container costs by designing ones that can be used over and over again. The most striking cost reductions have been accomplished by package machinery manufacturers and the most dramatic example is the application of the photo-electric cell. The "electric eye," as it is frequently called, is being used where printed wrappings are such that the printing must be located accurately upon the wrapped object as opposed to the wrapper that can be placed in any position. Packages of gum with printed panels on four sides provide a good example.

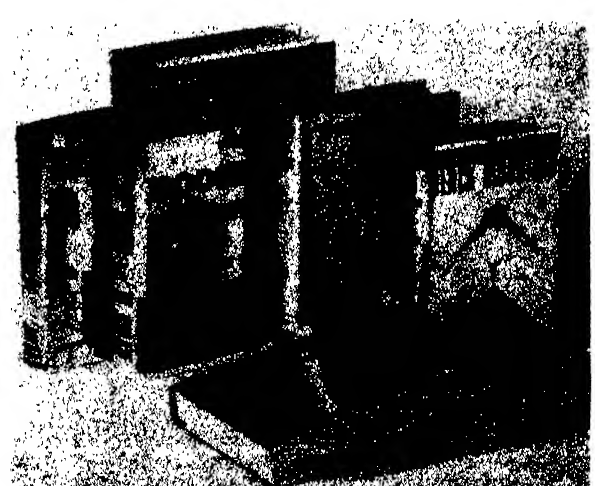
The job of the "electric eye" is to control the cut-off on the individual wrappers as they are fed from a roll on the machine. The roll is generally arranged to feed about $^1/_{64}$ or $^1/_{32}$ of an inch more than the actual spacing of the printing on the web. Then, when the printing design creeps ahead, allowing the light to fall on the cell, the cell operates to shorten the cut-off of the wrapper, usually by twice the planned over-feed. In this manner accurate register is obtained within fine tolerances. There are variations in the use of the "electric eye" for packaging but the purpose is always to shorten the cut-off if the machine is set to over-feed, or to increase the cut-off if set to under-feed. In either case, correction of the register is made intermittently.

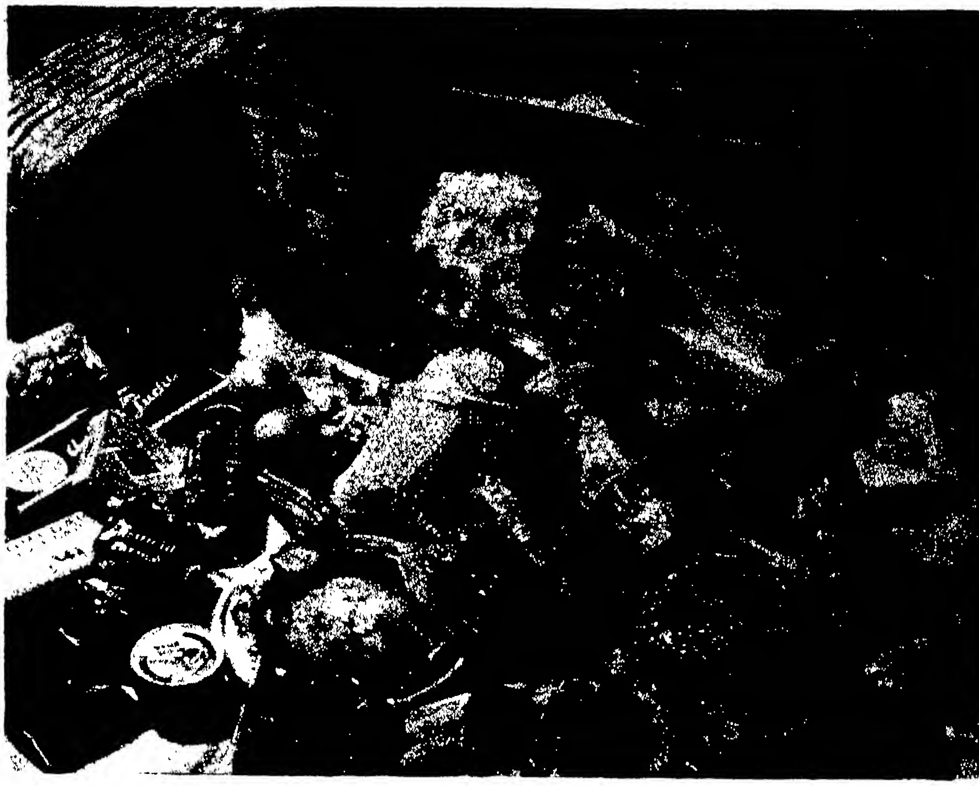
Packaging machines in use today accomplish unbelievable things and at speeds unthinkable in years past. Wrapping close to 100 cigarette packs a minute; opening cellulose bags, and filling, closing, and sealing them at the rate of one a second; hooding milk bottles at more than 100 a minute; and banding cigars and putting them in cellulose tubes at the rate of 40,000 a day, are some striking performances. There are machines which take a strip of transparent cellulose, draw it over a milk bottle and band the cap so formed; there is another which will take a sheet of transparent wrapping, fringe it on two edges, wrap it around a piece of candy, and twist the fringed ends. All manner of odd shaped objects are now being wrapped successfully by such rapid mechanical processes. Each application of the machine to wrapping is unique, worked out laboriously to the end that wrapping can be improved without an exorbitant increase in cost.

THE development of packaging to reduce costs is quite in keeping with the times. It is perhaps best exemplified in the move to make containers lighter, more compact, and re-usable. Quite recently a box was placed on the market which is collapsible, requires no nails, has no center partition, and is materially lighter than its orthodox predecessors. It is claimed that it saves one third in packing costs and 10 percent in freight charges. Another development is a bag for perishable foods which contains pockets for dry ice. When the contents have been removed, the bag can be folded, bundled, and returned for use again.

One may conclude from the foregoing survey of packaging practice that there is much in it that smacks of fad. And this raises the question whether the packaging boom will last. Looking at the most obvious examples—the redesigning of packages to enhance appearance and the wrapping of articles heretofore sold in volume without wrapping—people wonder what will be left of competitive advantage when every package is redesigned. The answer is that packaging is not static and there is no reason for believing that the last word has been spoken. There are fads in packaging and fads change, but packaging goes on. Competition forces improvement in containers, and compe-

Strictly modern: Aluminum foil jackets, carrying printed designs in the modern manner —the sort of packaging originality that compels attention and thus increases sales and profits





Ubiquitous Cellophane protects while permitting display of foods

tition is unceasing. The battle which goes on behind the scenes between the makers of wood, paper, glass, foils and all the other packaging materials is a reflection of the movement toward better packaging, because, although each purveyor wants to play a larger rôle, his ultimate status hinges on the suitability of his product for specific jobs commensurate with costs.

When a meat packer reports a sales increase of 20 to 100 percent in a few months following the repackaging of his product, when a department store, through tests, discovers wrapped hosiery outselling unwrapped 12 times, though displayed at adjoining counters with prices higher on the former, packaging has validity. The staunchest concerns see merit in it; witness Montgomery Ward. This company thought packaging so important that it established a Bureau of Design and out of it has come a broad plan involving simplification of packages and even a re-designing of contents. With many thousand items carried, Montgomery Ward's re-packaging moves slowly, but already sales have increased in every department where action has been taken. General Foods, mammoth of the food industry, has a Carton Committee. On this committee there is a representative from each of the research, sales, advertising, legal, and production departments. It is the duty of this group to study packaging thoroughly and advise on matters of appearance, utility, style, and the development of new package types. Ford Motor is another convert to the packaging idea. Ford has divided parts into six groups with special color designation, and the gains reported are better merchandising and instant, accurate inventory.

INDEED, packaging is here to stay and destined to become more highly specialized. The competition which forces it, also forces a high degree of consideration to every phase, for costs cannot get out of bounds or ends are defeated. It has been said, and it is significant, that manufacturers are much more interested in improvements in production convenience and economies in packaging than they are in attractiveness of design. We may anticipate, therefore, more and more thought being given to packaging in relation to the product, carrying back to consideration of the product itself, to the use of cheaper materials, and to a higher degree of mechanization in production processes.

That costs have risen out of proportion in certain instances is a fact. And there is a reaction to it, manifesting itself in a search for substitute materials. Over-packaging may be a nuisance and may even lead the consumer to question the value of the contents. Poor laundry work, for example, cannot be offset very long by putting the shirt in a paper, cardboard, metal straight-jacket. Producers are not slow to sense this possible reaction to paying for the wrapper and the re-usable container is one answer. We may expect to see much more development of this type of packaging wherein the dual value creates double purpose buying.

If for one moment anybody thinks all packaging problems have been solved, the example of milk distribution will disabuse him. For quite a while milk distributors have been testing out and pioneering the use of fiber containers. Hence, the time may come when a container will be perfected allowing sight of the cream even as we now have tin cans with glass tops. But whatever it may be like, its cost must be below that of the orthodox glass bottle.

When a concern adopts a new form of package and it gets all the advantage of the innovation, costs don't have to be studied very closely. When competitors adopt a similar package, the advantages may slip away, even to nothing, and leave behind principally high packaging costs. Something of this kind happened in the packaging of oil in cans. It was a big jump from bulk oil to canned oil, involving new problems of distribution, and oil companies would now like to lower their costs. They cannot return to the old methods if they would for the public has been taught to demand sealed cans, so they look for a savior in the form of a cheaper container.

WHERE packaging promises to make its most lasting contribution to this age is in the handling of articles which deteriorate between the time of production and consumption. It has accomplished, a great deal already in solving the problem of moisture retention and protection from moisture. It has demonstrated effectiveness in aiding the shipment of perishable foods by facilitating the maintenance of proper temperatures. It has been instrumental in controlling bacterial action and safeguarding products from light rays. From the Pacific Coast come reports that transparent cellulose wrappings will keep the saw-tooth beetle from foods and no less a person than Mayne R. Coe, U. S. Department of Agriculture expert, declares that millions can be saved by the food industry by protecting products from destructive light rays.

All these developments hint at accomplishments to come, and delineate one of the broadest channels for packaging progress. When they materialize, the advantages will accrue not only to the individual consumer, but to the nation.

Photos courtesy of:
Du Pont Cellophane Co.
Reynolds Metal Co.
Toledo Synthetic Products
Continental Can Co.
The Glass Packer
Package Machinery Co

Sundials and Their Construction

Part IX—The Principle and Construction of the Armillary Sphere

By R. NEWTON MAYALL
Landscape Architect
and MARGARET WALTON MAYALL, M.A.
Research Assistant, Harvard College Observatory

THE Chaldean astronomer, Berosus, who lived about 370 B.C., is generally acknowledged the inventor of the hemicyclium, which was a crude time-telling device hollowed out of a block of stone. This instrument was used for many centuries and, according to the writings of the Arabian astronomer Albategni, was in use as late as 900 A.D.

At the time of Berosus, the picture of our universe was that of a hollow sphere with the earth at its center. About 255

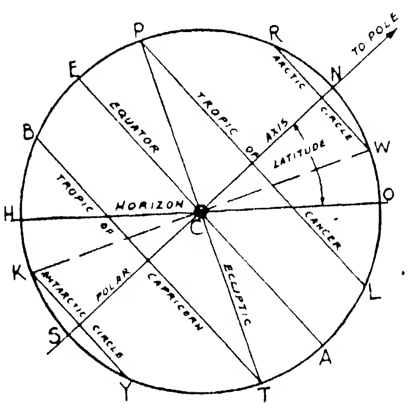


Figure 1: **Principle of armillary**

B.C., Eratosthenes, an astronomer and mathematician of Alexandria, devised an instrument to represent the system of the universe. This instrument consisted of many rings put together in the form of a hollow sphere with a globe suspended in the center, which portrayed the heavens encircling the earth.

Usually ten rings were employed, denoting the ten major circles of the sphere placed in proper relation to each other. They were the (1) meridian, (2) horizon, (3) equator, (4) ecliptic, (5) Tropic of Cancer, (6) Tropic of Capricorn, (7) North Polar or Arctic Circle, (8) South Polar or Antarctic Circle, (9) equinoctial colure, and (10) solstitial colure.

Such was the armillary or armillary sphere.

FIGURE 1 shows the construction of the armillary, in diagrammatic form.

In the figure the circle *HENAS* represents the meridian, and the line *SN* the polar axis of the sphere, with its poles at *N* and *S*. When properly set up, *NS* lies parallel to the axis of the earth.

A globe is suspended at the center *C*.

The line *HO*, drawn through *C*, lies parallel to the plane of the horizon.

The equator *EA* is perpendicular to the polar axis *NS*, at *C*.

The ecliptic *PT* is drawn through *C*, making an angle with the equator of 23°27′, and it cuts the sphere at *P* and *T*. The points *P* and *T* represent the greatest northern and southern declination of the sun.

The Tropic of Cancer is represented by *PL*, and it is drawn through *P* parallel to the equator, because it is a circle of latitude.

For the same reason the Tropic of Capricorn, *TB*, is drawn through *T* parallel to *EA*.

In like manner the polar circles are drawn. The dotted line *KCW* is perpendicular to the ecliptic at *C*, and cuts the sphere at *W* and *K*. These two points are called the north and south poles of the ecliptic. The north and south polar circles are noted by the lines *WR* and *KY*, drawn through *W* and *K*, parallel to the equator.

The equinoctial colure is indicated by the line *SCN*. It passes through the points where the equator crosses the ecliptic, and the north and south poles of the sphere. When the armillary is used as a sundial, it is generally a stationary sphere, in which case the equator will cross the ecliptic at the east and west points of the horizon, with the vernal equinox or sign of Aries at the west. (See page 139, September, 1934, number.)

In the diagram, the solstitial colure coincides with the meridian, shown by the circle *SENA*. This circle passes through the poles of the sphere, the zenith, and nadir. Its plane is perpendicular to the plane of the equinoctial colure.

THE armillary sphere in Figure 2 is so constructed that it shows the apparent motion of the heavens and the real motion of the earth. Suspended within the rings is a small sun, which moves about in the path of the ecliptic; and a small moon is so inserted that its motion is portrayed. The globe at the center turns upon its axis. The horizon may be elevated or depressed at will, and the rings may be turned about their common axis. The whole instrument may be adjusted in any latitude by means of the quadrant directly above the base.

The armillary was used by ancient astronomers for observational purposes. Although the hemicyclium and its successor, the conical dial, were in use at the same time, no mention is made in early Latin, Greek, and Arabian manuscripts, of the armillary as a sundial. Vitruvius, a Roman architect of the 1st Century B.C., listed all dials known in his time, but he does not refer to the armillary as such; Albategni, who showed the construction of horizontal dials as early as 900 A.D., does not mention it as a timekeeper.

From the abundant material to be found in early English and European treatises on gnomonics, as well as the more modern works on the subject, the authors have endeavored to place the appearance of the armillary as a sundial. Even as late as the 17th and 18th Centuries, when all dialists were fa-

***Figure 2:* An 18th Century armillary sphere, reproduced from Ferguson's Lectures. Described in text**

miliar with the functions of this instrument, it was used to solve problems of the sphere, and, peculiarly, to lay out sundials.

Ferguson, a prolific writer and astronomer of the 18th Century, describes the armillary, and clearly defines its use as "an instrument with which easy calculations can be made." He also describes one of glass, invented by Dr. Long, which depicted the position of celestial bodies and their relation to the circles of the sphere, and the motion of the planets—all operated by machinery.

That the armillary sphere may be used as a sundial is evident: it seems improbable that the ancients did not use it as such. Today it is common, and one of its simplest forms would be that of a hoop elevated above the horizon, so that it lies parallel to the plane of the equator. The inner surface, divided into 24 equal parts, would give the hours of the day. A rod suspended in the center, perpendicular to the plane of the hoop, would lie parallel to the axis of the earth and point to the pole, thus serving as a gnomon.

FIGURE 3 shows a sphere constructed with three hoops, or iron bands. The band *HO* lies parallel to the horizon: the meridian circle is represented by the band *NMOSE*; the equator is shown by the band *EM* (lying parallel to the plane of the equator), on whose inner surface is inscribed the hours. The gnomon *NS*, perpendicular to *EM* and pointing to the pole, completes this instrument.

The elements of the armillary have been described and are illustrated in

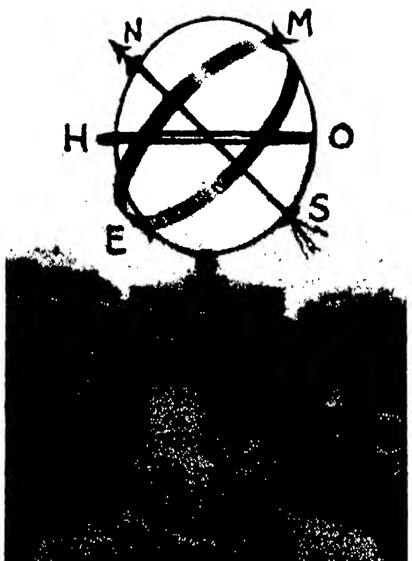


Photo by the author

***Figure 3:* A simple sphere built with three hoops of metal, and not at all difficult to construct of metal bands**

Figure 1. It is not necessary to use all of the circles when the instrument is to be a sundial, but it must be remembered that the hours are inscribed on the equator and the signs of the zodiac on the ecliptic.

One of the finest armillary spheres in this country (Figure 4) is situated on the campus of Phillips Academy in Andover, Massachusetts. The authors are indebted to Dr. Claude M. Fuess, Headmaster of the Academy, who kindly furnished the accompanying photograph and the following description, written by Mr. Paul Manship, the designer and sculptor of this unique sundial.

"The path of the sun is shown by the Ecliptic and the Signs of the Zodiac are portrayed in high relief on the band of the equator. The shaft, representing the axis of the earth, points to the North Star; and its shadow on the belt of the equator indicates the hour. The four Elements, as well as Dawn and Evening, figure in the decorative scheme: Water in the wave motif, with the Earth motif growing out of it; Air is represented by the ribbon, and Fire on the flaming meridian. The whole is supported by turtles, emblems of eternity. Man, Woman, and Child make up the Cycle of Life, as the sphere itself symbolizes the Cycle of Eternity."

This sphere with its pedestal and base, as a unit, might well be symbolical of character, strength, and dignity, thus being an ever-present reminder of the responsibility of all such institutions to men in the making.

***Figure 4:* One of the finest armillary spheres in this country is on the campus at Phillips Academy (Andover, Mass.)**

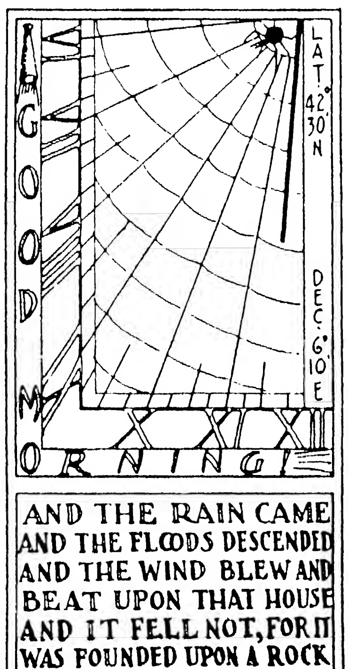


***Figure 5:* A south declining dial**

From the designer's point of view the armillary sphere is probably the most flexible type of sundial. It may be easily molded to suit one's fancies or interpretations.

BOOKPLATES often reflect the owner's interests by means of symbols. The sundial may be similarly designed, or it may serve in a descriptive capacity. This is exemplified in Figure 5, which shows a south declining dial designed by Mr. A. G. Ingalls, an enthusiastic amateur worker in stone masonry. "This dial," he says, "is to be made of sandstone and set into the wall of a rock cabin which I am building as a sort of 'island' just off the shore cliffs of Seneca Lake with its foundations resting solidly on a submerged stratum of Devonian rock. Because of the high cliffs immediately to the westward, the sun sets here at noon and the dial is therefore provided with morning hours alone." The hearty welcome "Good Morning" doubtless alludes to cheeriness within despite the presence of the sinister spider, while the biblical quotation in the panel below the dial refers to the situation of the cabin among the waves and on a solid rock foundation.

The earmarks of a good sundial are accuracy, craftsmanship, and design.

Accuracy in laying out the elemental lines on the dial plate is of prime importance, and good craftsmanship speaks for itself.

The dial with its support may be treated as a structure and, as such, it should be sincere in design; that is, be concordant with its surroundings or blend harmoniously with other structures in its vicinity.

The Oddest Thing About the Jews

By VICTOR W. EISENSTEIN, M.D.

THE essential difference between Jew and non-Jew has been often sensed, less often clearly discerned. Physically, there has been enough distinction in the Semitic physiognomy to prompt that common remark, "He looks Jewish," even though the object of that expression was an Italian or a Syrian. Yet neither the beard, nor a hooked nose, nor curly hair are exclusively Jewish adornments. Psychologically, a curious obsequiousness of behavior and clannishness of relationship have been thought to be distinguishing features of the Jew. Yet all these are relatively inaccurate impressions by comparison with a truly irrefutable distinction in *vital* makeup which exists and which really characterizes him. Rarely has the contrary nature of the Jew in a basic and organic sense been suspected, let alone proved, until the comparatively modern science of vital statistics forced the truth of this disparity upon us.

Even the modern Jewish youth in college would be most reluctant to admit the existence of any such gross physical dissimilarity between himself and his Gentile schoolmate. He might, indeed, resent such implication with the echo of Shylock's protest:

> "Hath not a Jew eyes? hath not a Jew hands, organs, dimensions, affections, passions? fed with the same food; *subject to the same diseases, healed by the same means . . . as a Christian is?*"

NEVERTHELESS, medical science does not regard Shylock's question as being merely rhetorical. That the Jew is not "subject to the same diseases as a Christian is" becomes increasingly apparent with every contribution to racial demography; in fact, the vital statistics show the Jew to be so peculiar in expectation of life, and in both the diseases to which he is susceptible and the immunities which he enjoys, that he presents a unique risk, and might almost be entitled to a separate schedule of premium rates.

The distinctive health record of the Jew of today is largely but a fragment of his biologic record. Like the story of the evolution of an animal species, which is revealed by the imprint on rock or by the growth of an embryo, the history of a race is often disclosed by characteristics embodied in its members; and, in the case of the Jew, these traits reflect the unmistakable traces of an age-long persecution. The small stature, the slight physique, and the proverbial excitability of the Jewish race eloquently tell the tale of the past 2000 years. Certain health hazards which are incident to being a Jew are likewise the results of that peculiar racial experience, and though these are less obvious than his bodily characteristics, they are nevertheless more definite than the alleged curl of his nose.

Diabetes, for example, is notoriously a Jewish disease, approximately one fourth of the members of the facetiously termed "Diabetic Club of America" being Jews. Accurate records gathered the world over, from Leningrad to New York, thrust upon the Jews the unenviable distinction of having two to six times as many diabetics as any other race on the face of the earth. Obese individuals are the usual candidates for this affection, and obesity is far from rare among Jews.

NERVOUS ailments have also been found to rank high among the afflictions of the Jews, and these, to some extent, account for many of the aberrations of behavior which non-Jews so quickly perceive about them. That the Jews are the most nervous of all civilized peoples has been established as almost axiomatic in the medical profession. It has been observed, for example, that the condition known as hysteria, which is but an unbalanced emotional state, presents its protean form more frequently in the Jewish element than anywhere else in the population, while a host of related functional derangements of the nervous system are met with two to three times as often among Jews as among any other group. In this light it is not surprising to note, as did a leading insurance company, that the suicide rate among the Jews of Prussia (even before the Hitler régime) was equal to the combined rate for the other two religious confessions in that region.

Not only in nervous diseases, but wherever nerve influence is a factor in disease, the Jew bears the brunt of the attack. Physicians know, for example, that Buerger's disease, which causes cramps of the legs, and angina pectoris, which causes excruciating pains over the heart, are both diseases which are more frequent among Jews than non-Jews. They know, too, that near-sightedness is more common in Jewish children, as is hardening of the eyeball (glaucoma) among Jewish adults; and that a certain rare form of idiocy with blindness is exclusive to Jewish infants. Recently they have found that a certain facially coarsening and disfiguring glandular disease known as acromegaly affects Jews inordinately, as does a certain enlargement of the spleen known as Gaucher's disease.

JUST why the Jews are most susceptible to these diseases will become apparent further on. Suffice it to say here that their diabetic and nervous heritage dates back almost to the exile of the Hebrews from their ancient Homeland (70 A.D.).

Just as there are conditions to which the Jew is definitely predisposed, there are many against which he is as definitely protected. In former years the infectious diseases were the prime causes of death, and it was in relation to these that the Jew enjoyed his greatest immunity. Today the cardinal causes of death are: heart disease, Bright's disease (nephritis), pneumonia, cancer, and tuberculosis; and these, to various degrees, are the chief causes of death in all civilized communities. In localities where comparative statistics for religious faiths are collected, the data indicate that the Jews apparently have a somewhat lower mortality from the dread heart and kidney diseases than the general population in the same localities. In Budapest, for example, the Jewish mortality rate from the degenerative heart and kidney affections has been reported as two thirds and four fifths, respectively, that of the rest of the population. Somewhat similar figures obtain in Russia and other European localities, where such records are available, although such data are as yet too scant to be entirely reliable.

But it is in the realm of the infectious

diseases that the Jewish mortality experience is really outstanding. Measles, smallpox, diphtheria, cholera, and the like claim only half the toll of lives from among the Jews as from an equal number in the general population affected. In the history of the world there have occurred repeatedly widespread epidemics, which seem to have swept through the land with the severity of the memorable plague of the Egyptians, and which likewise "slew very many of the first-born in the Kingdom of Pharaoh, yet spared the children of Israel." Typical was the cholera epidemic of Russia, in the late war, when the relative death rates from this disease were 29 for non-Jews; 6 for Jews. Recent European statistics accredit the Jews with only one tenth of the smallpox mortality, three fourths of the scarlet fever and diphtheria mortality, and less than half of the measles mortality observed among the other peoples in the same communities. Noteworthy in this connection, too, is the fact that venereal blood infection is said to occur in Jews about one fourth as often as in Gentiles.

PNEUMONIA is the most dreaded and fatal of all acute infectious diseases, ranking third among the chief causes of death in the American experience, being outranked only by heart disease and cancer. Yet pneumonia, often regarded as "captain of the men of death," orders Jews to the grave only half as often as it does their neighbors. Perhaps it is in the deliverance from the dreaded toll of the infectious diseases that the Jews still merit some claim to their ancient title, "The Chosen People."

While the infectious diseases are becoming less prominent among the causes of death, cancer is becoming more and more conspicuous. Cancerous conditions rank today as the second leading cause of death among women of middle age in this country. Most frequently the site of such growths in women is in the pelvic organs, such tumors constituting 15 percent of all cancers in this sex. When comparative racial experiences with cancer were recently compared the amazing discovery was made that fatal cancer of the uterus is less than one fourth as frequent among Jewish females as among the general population. The lessened susceptibility of the Jewish women to these relatively common malignant growths makes quite a favorable showing in the general mortality experience of the race.

Among the "Big Five" of the fatal powers which stalk among the American people, tuberculosis is still present and potent. Public health measures have done much to lessen the ravages of the white plague in this country; still, this malady is of great importance, and takes off a disproportionate number of

Why Jews Have Some Diseases More and Others Less than Gentiles . . . First Class Insurance Risk . . . Most Nervous People on Earth . . . An Effect of Inbreeding, Either Very Good or Very Bad

the population. Yet, in this country, as in the world over, the ranks of the Jews are decimated less often by the ravages of tuberculosis than those of their neighbors. It is curious that from the earliest times the Jews were never too gravely affected by this malady. There are no ancient Hebrew words for "cough" or for "tuberculosis." Today the consumptive death rate among the Jews throughout the world is about half that among their neighbors, while in the city of New York the Jewish population has only about one fourth the tuberculous mortality observed among the Italians and Irish. The fact that the Jews less frequently die from these most formidable and fatal diseases, notably the dread infectious diseases, makes the usually cited freedom of the Jew from the pork-tapeworm infestation pale into puny insignificance.

Painting by Betty Byrne, courtesy of *Asia*

A Chinese Jew. Contrary to common belief, Jews mix with all races

Just why is the Jew so peculiarly predisposed to certain diseases? Why for instance does he bear the brunt of diabetic and nervous affliction? The answer lies chiefly in his racial history, and partly in his mode of living. That the Jew is the most nervous of civilized races is probably a legacy from his days of persecution. For centuries he had known the lot of inquisitions, pogroms, and discriminations. For generations, too, his people had been forced to herd together, to live and work within the confines of the crowded Jewish quarter —the "ghetto"—and in this herding process family ties were not merely preserved, but intimately welded. Marriage was virtually limited to members within the small group, both by the restrictions of Hebrew law and by the compulsion of the anti-Jewish oppression. In the space of a few generations quite a large number of the Jews in any given community became related to each other through more or less consanguineous marriage.

It is this close mating, technically "inbreeding," that developed the biological type known as the "pure-bred Jew." That this racial type is occasionally a high grade product is a fact frequently cited in favor of inbreeding. But there are terrible compensations for such superiority—for close blood marriages, while they intensify the desirable qualities, likewise exaggerate the defects in the offspring. The factors of inheritance add up both ways to increase the power of whatever traits exist in a family. Should a superior intelligence exist, that would tend to be transmitted to the child of such consanguineous marriage. On the other hand, if there were a tendency to nervousness or to insanity, that tendency might bloom too often as a glaring certainty in such offspring. Whether the "ace" or the "joker" will be dealt out of such family shuffles is a circumstance beyond certain prediction. The effect of this uncertainty is apparent in the Jewish race, into which many great characters have been born among a goodly sprinkling of unstable and neurotic individuals.

THERE are other effects of this herding process. Jews have developed in the course of centuries a defensive group-consciousness and a keen sense of family devotion. To this day the unique family relationships of the Jew shape his mind, his way of thinking, and even his mental aberrations. Dr. Brill, the psychiatrist, has pointed out the effect of an excessive "familialism" in the Jew. He observed that the tendency of the Jew to be overattached to his own particular group is a force which often contributes to his mental maladjustment. Because of such deep-rooted family loyalties the adolescent Jew often fails to make a proper social adjustment when he takes his place in the larger adult world. Failing to find the accustomed profusion of solicitude in his new environment, he retreats into himself and becomes an introvert. Thus he be-

comes a candidate for a neurosis or a frank psychosis. Apparently these factors have not been properly appreciated by those who perceived only the obvious clannishness exhibited by Jews as a race.

Often the tendency to nervous affliction which exists in the Jews is activated by the occupations which they follow. They have not, in the main, engaged in agricultural or other manual pursuits. Their choice of occupations in the past was conditioned both by their slight physical endowments and by the insecurity of life in a hostile community. The constant danger of expulsion precluded the possibility of any great attachment to the soil. For these reasons they have since earliest times engaged in pursuits demanding somewhat more of brain than brawn. They have always pursued business with a characteristic zeal, and this fact has probably played some part in weighting their mental burdens. The likelihood of mental breakdown under competitive economic stress is rendered all the more probable among offspring of a long line of consanguineous ancestors who were for the most part endowed with delicate mental mechanisms. Krafft-Ebing noted long ago that the nervous vitality of the Jewish race has therefore apparently diminished and that they may, therefore, expect an increasing share of the mental diseases, which run side by side with the advance of civilization.

IN explanation of the Jewish predisposition to diabetes, several factors contribute. The chief factors in the production of the diabetic state are obesity and sedentary occupations. The Jews are committed to both. Because worry and anxiety play predisposing rôles in this disease, it is readily understood why a train of diabetes has in the past followed in the wake of every business depression. This fact has been aptly expressed by the Jewish adage: "On Broadway, when business takes a fall, diabetes takes a rise."

The immunities to disease, like the predispositions exhibited by the Jewish people, are likewise not mere chance phenomena but have been developed through a most ruthless process of natural selection in past centuries. The armor against infection which the Jew has acquired has been strengthened by the hygienic mode of life which is his ancient heritage and, paradoxically, by life in crowded cities.

The infectious diseases, particularly tuberculosis, take their greatest toll among rural inhabitants who are exposed for the first time to urban conditions. This fact was well demonstrated during the World War, when almost as many deaths resulted in American training camps, where the boys from the country were brought together with those from the city, as upon the European battlefields where they met the enemy. Epidemics of influenza, measles, mumps, scarlet fever, meningitis, and the like swept the camps like wildfire, and those affected with greatest severity were those who had not been exposed to these diseases during childhood.

The Jews, however, who are the children and grandchildren of town dwellers, have already built up an effective immunity to these infections. For 200 years they lived almost exclusively in cities, often packed into ghettos, under which conditions those who were predisposed to tuberculosis, and the like, succumbed; the many who survived left a progeny likewise refractory to the disease. "The American Jew's advantage in respect to the contagious diseases lies in the fact that his ancestors have already been exposed to infections, not only in past centuries but even in comparatively recent-day Europe; for the Jewish immigrant," as Dr. Fishberg observed, "does not make any material change in his milieu by changing his abode from eastern Europe to America. He lived there in a city, and settles here again in a city. He worked there at an indoor occupation and does the same here. He lived there in overcrowded quarters, and moves here into a 'double-decker' tenement."

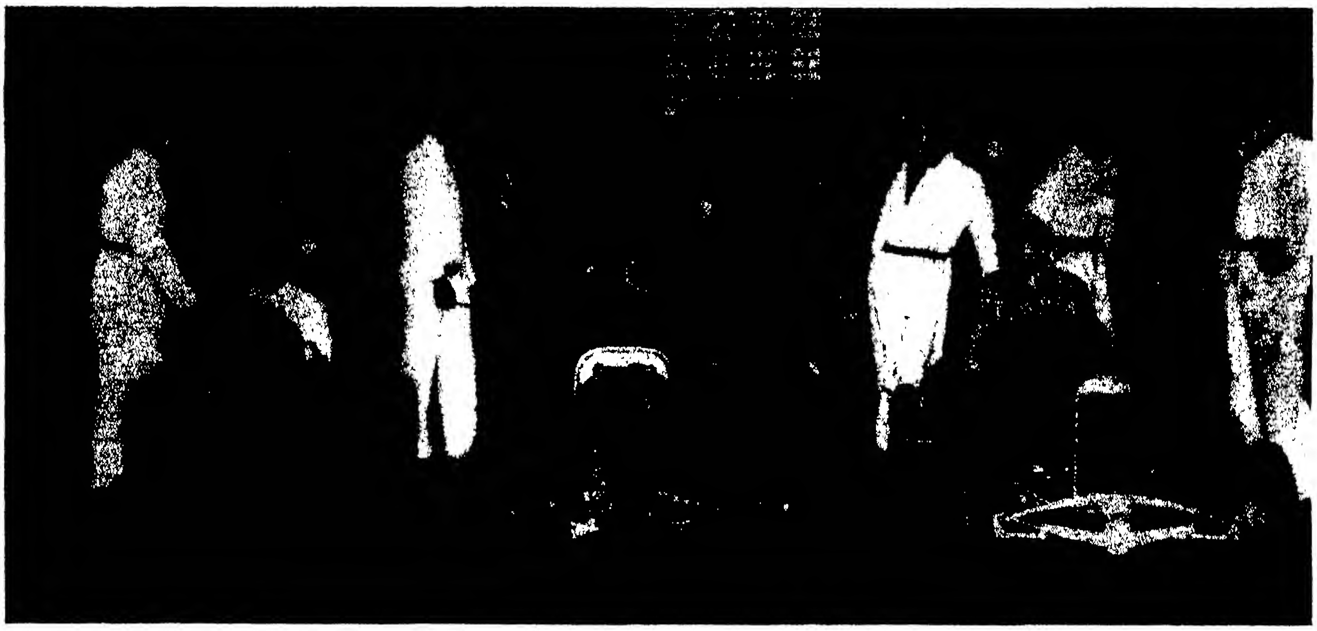
THE relation of city life to active immunity against the infectious diseases was strikingly demonstrated in Palestine after the late war, when for the first time the city-bred Jews of Europe began commingling with their hitherto rural brethren, the Jews of Yemen. Tuberculosis at once ran rampant among the previously unexposed Yemenites, at the same time sparing the European group. A more diabolical experiment could hardly be contrived to prove that not race, but city life confers the peculiar kind of immunity which the Jews enjoy in relation to tuberculosis.

Undoubtedly there are other factors which play a part in this immunity, such as the mode of living and the habits of eating and drinking. As a rule the Jew has subsisted on inspected "Kosher" foods, has been always temperate in regard to drink, has avoided outdoor occupations in rigorous climates, and has always sped to the doctor with every slight (and even imaginary) ill—with the consequence that he has altogether avoided many struggles with serious acute illness. That the Jewish resistance is not entirely inherent becomes evident when one notes the effect of social conditions upon the so-called "racial" immunity. Intermarriage, for example, does not seem to increase the Jewish susceptibility to the "white plague."

After observing the conditions which add to or detract from the chances of life afforded to the Jew, it is natural to inquire: "In whose favor does the balance lie?" "How does the expectation of life among the Jews differ from that among the other people?" In so far as vital statistics can give an answer, the advantage is distinctly on the side of the Jew. The chief causes of death molest the children of Israel but little as they cross the bridge of life. The mortality rates of the Jews, *at all ages*, are relatively and absolutely lower than those of the people among whom they live. Owing chiefly to their immunity from the infectious diseases, the Jews lose relatively fewer children and bring more to maturity than their neighbors. Dr. Billings, one time Surgeon General of the United States, pointed out that "The average annual death rate (7.1 per thousand) among Jews is little more than *half* of the annual death rate among other persons of the same social class and conditions of living in this country," and that "*the Jewish expectation of life at each age is markedly greater than that of the class of people who insure their lives; the average excess being a little over 20 percent.*"

IT is only because of this remarkable tenacity of life that the Jew has survived the 2000 years of persecution which he has encountered. He has, in fact, emerged from his buffets and his wanderings, a first class insurance risk!

Whether the balance of life will remain in favor of the Jew is problematical. To the extent that his immunities are inherent in the race, they will be handed down into his children's children. Intermarriage alone can diminish the extent of purely *racial* protection, and intermarriage is already far from a rarity. Perhaps it is a wise plan of Nature that the Jew, as his life becomes easier and free from oppression and as he therefore needs no additional biological defenses to survive, should turn to assimilation, and so lose this type of protective armor. As we follow the gradation from the purebred or "inbred" Jew of Russia to such "interbred" varieties as are found in Germany, England, and the United States, we perceive that the tenacity of life of the Jew and his resistance to certain diseases gradually diminish as we proceed from east to west. To the extent also that the Jew adopts the mode of life of his Gentile neighbors, follows similar occupations, eats and drinks to the same quality and extent, and even develops the same psychology—to that extent does he likewise approach their vital capacities. Wherever the Jew is thus commingling with the people among whom he lives, he gradually loses his hygienic "racial characteristics" and his comparative demography presents no peculiarities. He is then hardly a "preferred risk."

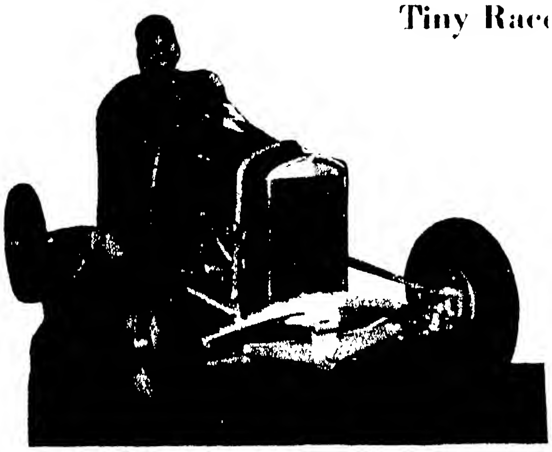


Getting ready for the start of a midget race on an indoor track. Car at right is described below

ROARING MIDGETS

Tiny Race Cars Are Developing a New High-Speed Sport

By A. P. PECK



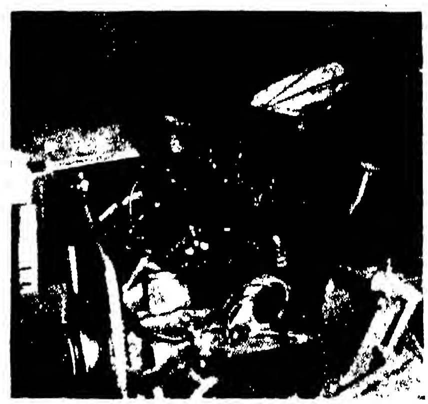
A midget race car powered with a four-cylinder outboard motor developing 65 horsepower

MOTORS screaming, tires squealing, drivers grimly intent on getting ahead or keeping there, midget race cars are setting new records on equally midget tracks. This new sport is attracting thousands of devotees among the spectators, many of whom have never before been interested in racing, but who are fascinated by the tremendous speed developed by these tiny cars. An indoor track, one fifth of a mile in circumference, is drawing large crowds in New York City, and the next summer will probably find many similar ovals throughout the country.

Looking into the "cockpit." The gear-shift lever is in the center

One of the most consistent performers at the New York track is the little car illustrated here. Designed by Edward Hauptner of City Island, New York, this midget cost well over 1000 dollars and is an excellent example of intelligent design. The power plant is a 4-60 outboard engine especially adapted for the job. The motor is placed on its back and securely mounted in a sturdy frame. A water pump, belt driven from the drive shaft, keeps the motor cool even at high speeds.

The normal rating of the motor used



Under the hood. The motor is equipped with a down-draft carbureter

is 60 horsepower at 5800 r.p.m. It has been "pepped up" to a point where, turning over 6600 r.p.m., it delivers 65 horsepower.

The wheel-base is 70 inches and the tread 43 inches. Tires 20 by 4 inches are mounted on disk wheels.

Because of the short straight-aways on a fifth-mile track, the best average speed of this car is about 48 miles per hour for several laps. At times, however, it travels at a speed of 75 for short distances. The theoretical top speed, calculated from engine speed and gear ratios, is around 128 miles per hour.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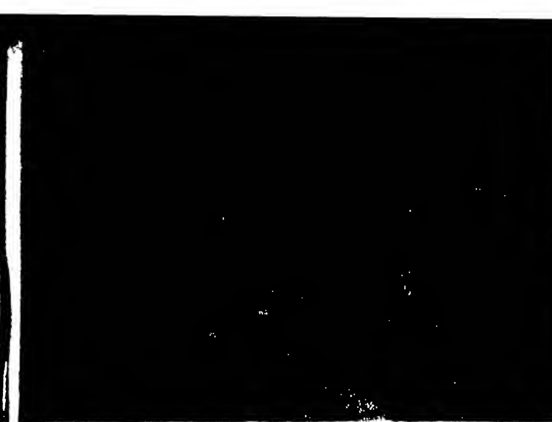
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From left to right: **1, dilapidated and aban doned; 2, the same house after remodelling 3, an unkempt and unhealthful farmhouse; 4 a section in Chicago soon to be replaced b modern apartments; 5, New Jersey house wit new insulated wing (old section wastes hea as shown by the fact that all snow has been melt ed from the main roof); 6, Chicago's Ghett**

THE HOUSES WE LIVE IN

By DR. HAVEN EMERSON

President of The American Public Health Association

Professor of Public Health at the College of Physicians and Surgeons of Columbia University

AS long as man was nomadic, wandering over desert and through forest, making his home wherever he pleased, the problem of health was one which gave him little concern. But as soon as he congregated by an oasis, or at the fork of a river, or in a well-situated harbor, then began the necessity for healthful living. Without science it would have been impossible for man to develop the great cities of today. The problems of healthful housing, adequate water supplies, effective sewage systems, protection against fire and plague—all these must be answered before man can proceed to the more esthetic things in life.

If the tendency of the succeeding waves of civilization to be of longer duration, and of the intervals of barbarism to be briefer, is to continue, it can only come about through increasing wisdom in the control and processes of human life and a wise use of the agencies of wealth and power over material things.

Public health is founded upon scientific discoveries which are comparatively recent. There is an inevitable cultural lag between the acquisition of knowledge and its application to a community, and unless man is directly touched by imperfections in civilization he is inclined to ignore them. Although the desire for life and health is a basic human emotion, the absence of disease, the prevention of an epidemic or a city-wide fire, and the elimination of food shortages are all negative accomplishments which are not dramatized in the public consciousness. We do not realize that unless scientific housing and health continue, man may easily slip back to the days of plagues or even to barbarism.

Housing conditions in the United States today are alarmingly backward. We are, in housing, at least a century behind our achievements in transportation and communication and yet science has perfected many improvements which our public inertia has kept us from ultilizing. The National Housing Act is beginning to awaken people to the fact that we are desperately in need of improvements and that these improvements lie within our grasp.

Just what are housing conditions in this country? The statistics are appalling. Even in the colder sections of the country a bare 33⅓ per cent of residential buildings, including apartments and tenements, have central heating systems. In the rural areas, which include towns of less than 10,000 population, only about one sixth have plumbing in the house. Homes with running water are less than one fourth of the nation's total, while homes with electricity are less than one half.

MANY American homes are actually nothing short of fire traps, despite the fact that there are many fire-proof building materials on the market today. Twenty-three percent of all fires start on the roof and in rural sections as much as 75 percent begin there. Many home-owners are beginning to eliminate this danger by covering their roofs with fireproof shingles. Composed of materials that can stand the flame of a blow-torch (often of Portland cement and asbestos fibers), they are recommended in many communities where inflammable roofing materials are prohibited by law.

The average American home is wasteful of heat in winter, because it is not properly insulated, and uncomfortable in summer for the same reason. It has been estimated from responsible data that if all the residential buildings in the United States were properly insulated, there would be an annual saving of 100,000,000 dollars in fuel bills. When such an insulating material as rock wool is blown into the hollow wall space of homes, it not only reduces fuel costs anywhere from 25 to 40 percent, but also constitutes great protection against fire. Being factory made of molten rock blown into fine shreds by jets of steam it will not burn and effectively keeps fires from spreading from floor to floor.

Kitchens and bathrooms are too often finished in wood and hard to keep clean. Not only are there many homes lacking running water for bath, kitchen, and toilet but there are hundreds of thousands of homes where there is no privy of any kind indoors or out. In the southeastern portion of the United States there are thousands of schools which lack this elementary convenience so essential for health and the prevention of communicable diseases.

Homes hardly more than shacks or shelters throughout the malarial sections of the South lack screens for doors and windows upon which prevention of mosquito-borne infection depends. In many of our wealthiest cities, the priceless privilege of direct, and even indirect, sunlight is denied to homes in the shadow of tall buildings. Without light the human being, particularly the young and growing child, suffers as definitely as he does with an infectious disease.

How true are the words of Dr. Ray Lyman Wilbur in reference to present conditions: "The housing conditions of the wage-earning population of American cities and industrial villages, with surprisingly few exceptions, are characterized by ugliness, poor sanitation, overcrowding of buildings on land or of people within the dwelling or bedrooms. The number of wage-earning families affected by such unwholesome, drab, and uninspiring conditions runs into millions. The slums of our cities, and blighted areas—whether in cities, towns, or villages—are an economic and social liability and disgrace. No nation can afford to permit such conditions. They are too closely linked, not only with industrial inefficiency and economic incompetence on the part of their victims, but also with colossal annual expenditures on the part of public and private agencies for poor relief and social service which alleviate *after* the needless damage has been done. Where prevention is possible, cure is a costly experiment."

There are, fortunately, building improvements which can remedy these evils once public sentiment has been aroused. The National Housing Act is the finest piece of legislation passed in many decades and at the present time it looks as though it might accomplish the desired result. The main function of the Federal Housing Administration in my mind lies in its power to prevent conditions in neighborhoods which could eventually turn them into slums.

OUR announcement last month of a coming series of articles on various phases of housing stressed many pertinent, but general, facts indicating the colossal nature of the housing problem. Dr. Emerson is specific; his subject covers perhaps the most vital problem now facing us in housing: Human Health and Sanitation. Indeed, the future growth of the country hinges upon the working out of a solution to this particular problem, even as our future prosperity will be influenced largely by the extent of our present housing activities. We, therefore, commend those agencies—federal, corporate, and private—that are now so intensively promoting a consciousness of better housing.—*The Editor.*

There will always be slums as long as a certain percentage of mankind persists in slovenly, unhealthy habits. The finest dwelling place in the world can become a pig-sty if the essential health laws are flouted. It is through education of the people and by instilling in them a pride in their community that bad housing will be eliminated.

Until man has so emerged from the level of the beast that he has learned not to make his own shelter, his garden patch, his dooryard, the pathway to and from his work, a source of continuous pollution of his and his family's food, feet, and water, he cannot be considered to have started on the climb to social security. The transfer of feces to food is a particularly insidious result of the lack of proper sanitation.

THERE are a number of diseases, true scourges of man, which today are major problems of preventive medicine chiefly because of man's congregate existence in houses and in crowded sections. Tuberculosis, rickets, diseases due to vermin infection, and enteric diseases are all traced in a large part to bad housing conditions.

The cause of rickets in its full complexity is not yet known but it appears that the growing child from before birth to the age of two or three years cannot accomplish sound development of bone unless the body metabolism has the benefit of the stimulation which sunlight gives to the cells of the skin. Rickets contributes heavily to sickness and death from bronchitis and pneumonia in little children, and to lowered resistance to measles, whooping cough, and tuberculosis.

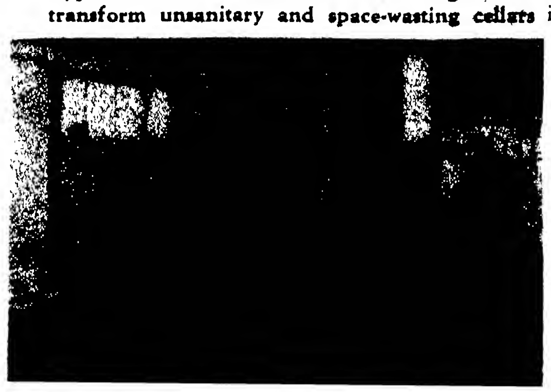
Bad housing is one component of a vicious circle of disease, others of which are drink, poverty, vice, carelessness, and ignorance. The evidence is abundant that the general death rate is low where the number of rooms per house is adequate for the inhabitants. Crowding to the extent of having more than one occupant per room is a factor in raising death rates.

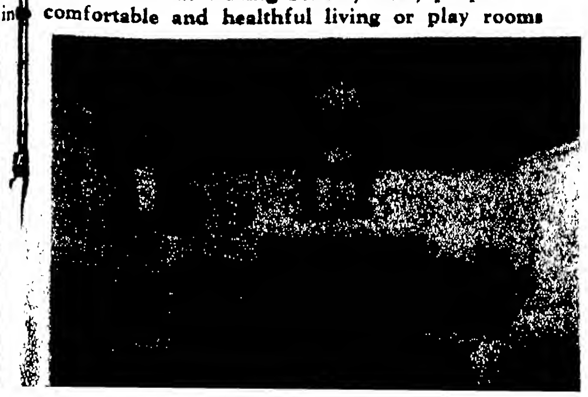
In Detroit, New York, Glasgow, and Edinburgh, studies have been made showing that increased prevalence of cases of and deaths from pulmonary and other forms of tuberculosis is related directly to houses overcrowded and poorly constructed. Jewish dwellers in dark, crowded, and otherwise undesirable tenements in Manhattan who moved in large numbers into much better spaced and arranged homes in Brownsville, Brooklyn, exhibited notable reduction of their tuberculosis mortality as compared with that of their fellows who continued to dwell in the old style tenements in Manhattan. Among industrial workers in Cincinnati, the United States Public Health Service found that bad housing had a marked influence on the tuberculosis rate.

Studies on infant and maternal mortality rates show a close correlation between loss of life from childbirth and in the first year of infant life, and the number of persons per room in tenement housing and particularly with the number sleeping in the same room with the infant. Darkness and crowding in rooms where home deliveries are the custom, and where the economic level of the family makes of the mother the sole house worker—and often also a wage-earner—are directly related to high maternal and infant death rates.

Thus we see conclusively how important to our health as well as to our comfort is the need for good housing conditions. The conditions which should be laid down for every house in America include the following points: first, a building weatherproofed and insulated; dry and easily cleanable interior surfaces; size proportionate to use, not less than one room per person; a great deal of sunlight; ventilation that assures cross air movement by windows opening directly to outdoors; water supply and efficient sewerage system; and, lastly, fireproof construction.

Typical "before and after" views showing what can be done—and what *is* being done by many people—to transform unsanitary and space-wasting cellars into comfortable and healthful living or play rooms





Creative Enlargement

Advanced Amateur Photographers Will Often Find it Possible to "Retake" Scenes in the Dark Room . . . Some of the Tricks of the Trade

By JACOB DESCHIN

OFFERING almost the equivalent of "retaking" a picture in the leisure of the dark room, the enlarging process in photographic work makes a special appeal to the creative sense of the serious cameraman. Its growing popularity, particularly among users of miniature cameras, is based on the opportunities it affords for altering the "framing" of the original negative, for recomposing the picture by deleting what is unwanted, for emphasizing the main point of the picture, and for enhancing the beauty inherent in the negative but unperceived and therefore unappreciated in the contact print made from the whole negative.

Like the journalistic photographer, the advanced amateur takes everything in his stride that seems to offer good "human interest" as well as pictorial material. Like his news contemporary, therefore, the independent worker finds that many of the most attractive pictures snapped in the streets or elsewhere are taken without full opportunity for properly composing the picture. He also finds that many pictures are taken from a point of view that does not permit correct lighting, or that does not limit the field of view strictly to the subject matter. On viewing the finished negative in the dark room for the first time, therefore, the worker discovers that, in a great many cases, better composition may be had by using only a certain portion instead of the entire area of the negative.

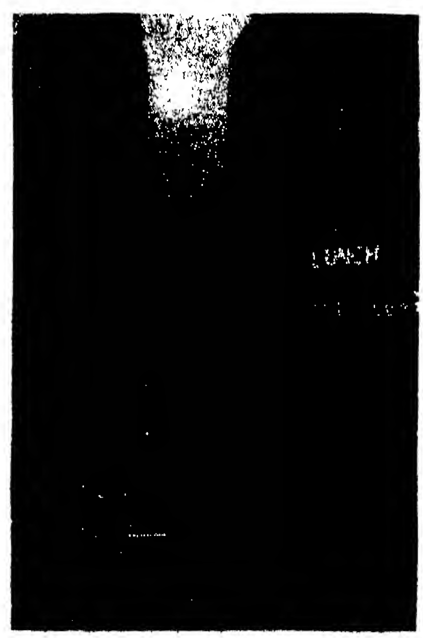
The great variety of so-called "fine grain" films now available makes it possible for even the miniature camera devotee, using a film the size of a postage stamp, to enlarge only a small portion of it up to as much as 8 by 10 inches or larger without appreciable loss of definition. Even where there is a lack of sharpness in the enlargement, this feature is even found desirable because of the pleasing diffusion which it gives.

ENLARGING cameras are divided into two general classes—the auto-focusing type, which brings the lens into correct focus at whatever point from the paper it is fixed, and the type requiring manual focusing. In the latter case, it is necessary for the operator to focus the image until it appears sharp on the paper. While the baseboard of the enlarger, or the table on which the enlarger rests is used by some as the "easel" on which the paper is placed, the paper being held by push pins, photographic tape, or other means, it is more satisfactory to use one of the many inexpensive easels on the market. These are adjustable to the size picture desired and give clean-cut margins, while holding the paper absolutely flat during the exposure.

The variety of bromide papers on the market may well bewilder the beginner in enlarging but since no reputable manufacturer can afford to turn out inferior material it is generally safe to pick one of the well-known brands and see what it will do. After having become thoroughly familiar with it, switch, if you wish, to some other brand, and later, perhaps, to still another brand. Eventually, however, choose one paper that peculiarly fits your style of working and stick to it. There is nothing like simplification of the printing process. After all, the big thing is the subject matter.

The brand of paper having been chosen, there is the matter of surfaces of the paper to be considered. Generally speaking, these include glossy, mat, semi-mat, and rough. While glossy prints are necessary in some instances, as when made for newspaper reproduction, the other surfaces will usually be found more pleasing. As a rule, rough papers are used for portraits and certain pictorial subjects, as landscapes and cloud effects, while the smooth papers are more desirable where rich detail and delicacy are wanted. Glossy papers, because they are offered in different grades of contrast, ranging from "soft" or "normal" for "contrasty" negatives to "extra hard" for flat negatives having little or no contrast, are useful in cases where a variety of contrasts is necessary, as in newspaper work. Bromide glossy paper comes in four different grades and chloride glossy in six. Since the "normal" papers retain every detail in the negative, including the most delicate gradations of tone, the clear, crisp, "transparent" negative should be the photographer's constant goal—and that means correct exposure.

The general procedure in enlarging



Improving the interest in a scene by cropping incidental material and strengthening (dodging) highlights

is the same as that for the making of contact prints, except that in enlarging the print is made by projecting the negative image to paper on an easel some distance away. As in contact printing, the dull side of the negative should face the paper.

"Test strips" should be made until the operator has become accustomed to the speed of the paper. These are made by cutting a strip about an inch wide from the kind of paper you are going to print on and focusing on it the principal object in the picture. Then, after covering with a cardboard or other opaque material all but a portion of the strip, turn on the white light and give a 10-second exposure or less. Then pull the card down to expose the first and another section of the strip for the same length of time (do not move the test strip itself); proceed thus until you have made a half dozen or so exposures. Each one will be 10 seconds less than the one preceding. Develop and fix this strip in the ordinary way and then view it in a bright light. When you have determined by careful study which section does the negative the most justice, insert a full sheet of the same paper and give it the exposure which was right for the correctly exposed section of the "test strip."

ASIDE from the mere limitation of the area of the negative to be enlarged—though this often calls for a real artistic sense, a lively imagination, and an understanding of the principles of composition—the worker's scope is greatly widened by the use of "dodging" methods and the various means of diffusion.

Diffusion, or the softening of definition of the image, is resorted to in pho-

tographic printing and enlarging in the production of pictorial and portrait work and in other cases where sharpness, a quality much desired in commercial photography and newspaper work, actually is a detriment.

Diffusion may be realized by any one of a variety of means. There are available diffusing lenses or screens for the regular enlarger lens. Where the enlarger lens may be adjusted to different stops, as on the regular camera lens, the worker may diffuse by starting the exposure at the full opening, after focusing on the center of the picture, and then stopping the lens down for over-all sharpness. A piece of black chiffon placed over the

Four enlargements (reduced for reproduction) from the same negative. *Above:* The entire area of the negative is used. *Left:* Composition improved by using only part. *Below:* Just the figure. *Extreme left:* The head of the subject vignetted

lens during all or part of the exposure will often produce pleasing diffusion. Another favorite method is to use an embroidery hoop and fasten in it a piece of silk, cheese cloth, or bolting cloth. The hoop is kept in motion between lens and paper during all or part of the exposure, depending on the amount of diffusion desired. In using any of these methods, the exposure time must be increased.

"Dodging," or the practice of using the hand, a cardboard, or some other opaque material to shade the more transparent parts of a negative while allowing more exposure time for the denser parts, is a very valuable and useful art which requires only a little practice to learn. "Dodging" is resorted to in cases where, if the entire negative or that part of it which is being enlarged were given the same exposure all over, either the highlights would get insufficient exposure or the shadows would receive too much. The procedure is to use the hand where suitable, or a piece of cotton or black paper at the end of a wire or long piece of glass, to shade the shadows after sufficient exposure has been given to show full detail, thus giving further exposure to the denser parts. Landscapes with clouds, and most negatives with strong contrasts are greatly improved by "dodging."

"Vignetting" or the process of printing only a certain portion of the picture, usually a head, while shading off all the rest, leaving the shaded part white, is liked by many for portrait work. A hole the size of the image to be printed is cut in a piece of cardboard somewhat larger than the area of the printing paper. This cardboard is interposed between lens and paper, and is constantly moved up and down during the entire exposure, the amount of motion determining the diffusion of the vignetted edges. In all "dodging" and "vignetting" the shading medium must be kept in continual motion or lines projected by the "dodging" medium will show in the final print.

The possibilities in enlarging are without limit. A search through your collection of negatives, even the ones which you have thought worthless, may reveal marvelous opportunities for producing beautiful enlargements from what are apparently trite negatives.

POPLARS OF PROMISE

Rapid-Growing Hybrids . . . 10 to 14 Times Faster Than Natural . . . 80-Cord "Crop" Per Acre in 12 Years . . . More Profitable Than Wheat . . . Boon to Farmers, Paper Makers, Lumbermen . . . Cut Importations . . . An Important Achievement

By R. G. SKERRETT

WHAT does paper mean to the average person, and in how many ways does he utilize so-called paper products? The facts are of great economic significance.

Seventy-five years ago, the per capita consumption of paper annually in this country did not exceed eight pounds. Today, it is close to 225 pounds! The term "paper" includes "boards" and other wood-pulp commodities, for the outstanding fact is that each and all of these products require pulp wood as a basic raw material.

There was a time—and that not so many years ago—when our forests furnished all of this essential wood; but we have used up most of those stands of timber far faster than nature could possibly replace them by normal processes. Wood-pulp and paper mills that used to stand close to virgin forests have, in most cases, stripped virtually bare those nearby areas and have had to go to distant points for their logs—thus adding each year to harvesting and haulage costs. Moreover, the dependence of American wood-pulp and paper plants upon foreign sources of essential raw materials has grown at a disquieting rate in latter years. That is to say, just as our uses of paper and paper products have approached their present volume we have had to rely increasingly upon other countries for the basic stock; and the price has mounted accordingly.

Systematic reforestation might, in the course of generations, place our domestic paper mills in their erstwhile favorable situation—always assuming that reforesting were done on a scale in keeping with the cutting of the mature trees. Even so, nature would not hasten the process of replenishment. A natural-growth poplar tree is not a size suitable for pulp wood until it has been growing from 45 to 55 years, and is then eight inches in diameter at breast level of an average man. A pine tree, to attain the same diameter, would require a growing period of 70 years; a spruce tree would take 90 years.

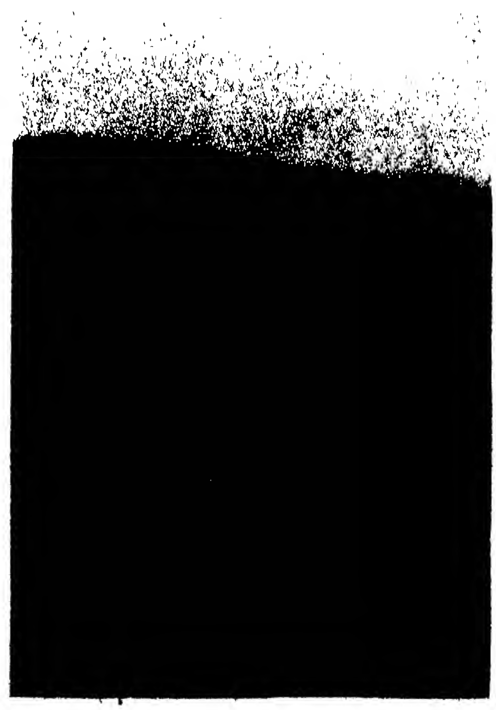
On the face of it, most farmers and other owners of cut-over timberlands would not be inclined to look so far ahead, especially as they would not, in all likelihood, live long enough to reap the benefit of their planting. It was just this discouraging drawback to reforestation that inspired Dr. Ralph H. McKee, of Columbia University, about 18 years ago, to study the raw-material problem of our paper industry.

AS Dr. McKee explains: "After considerable research, my technical associates and I were convinced that from the 25 or 30 varieties of poplars obtainable in this country and elsewhere we could deliberately produce crosses that would be radically different from any of those poplars and perhaps give us a new source of wood for paper-making. Any hybrid, to be acceptable, would have to have a wood of good color and of fairly long fiber, and grow a straight and long trunk to a considerable height before developing branches. Branches, at their junctures with the trunk, form discoloring knots; and the papermaker needs logs that are very light or white for most of his products—otherwise the knots must be removed before the wood is pulped, and that operation adds to the cost of production and reduces the amount of paper or pulp that can be manufactured from each cord of wood."

The poplars that were obtained by Doctor McKee and his associates through crossing are, so far as knowledge goes, unlike any others in existence. To be exact, they are freaks that are the outcome of definite acts on the part of man combined with utterly mysterious actions on the part of nature.

DESIRABLE and different varieties of poplars were found in the United States among collections in certain botanical gardens and also in several commercial nurseries on Long Island. Poplars, unlike many other familiar trees, are not bisexual but grow separately as male and female trees. This simplified the hybridizer's work. The flowers of the chosen female trees were safeguarded from normal pollination by bees and other insects by covering the unopened buds with paper bags. When the flowers opened, pollen was taken from the chosen male flowers and dusted on the selected female flowers—the protecting bags being momentarily removed for that purpose. The sheltered seeds ripened in six weeks and were then planted in a mineral soil favorable to germination. Doctor McKee's efforts were well rewarded, and again we shall quote him.

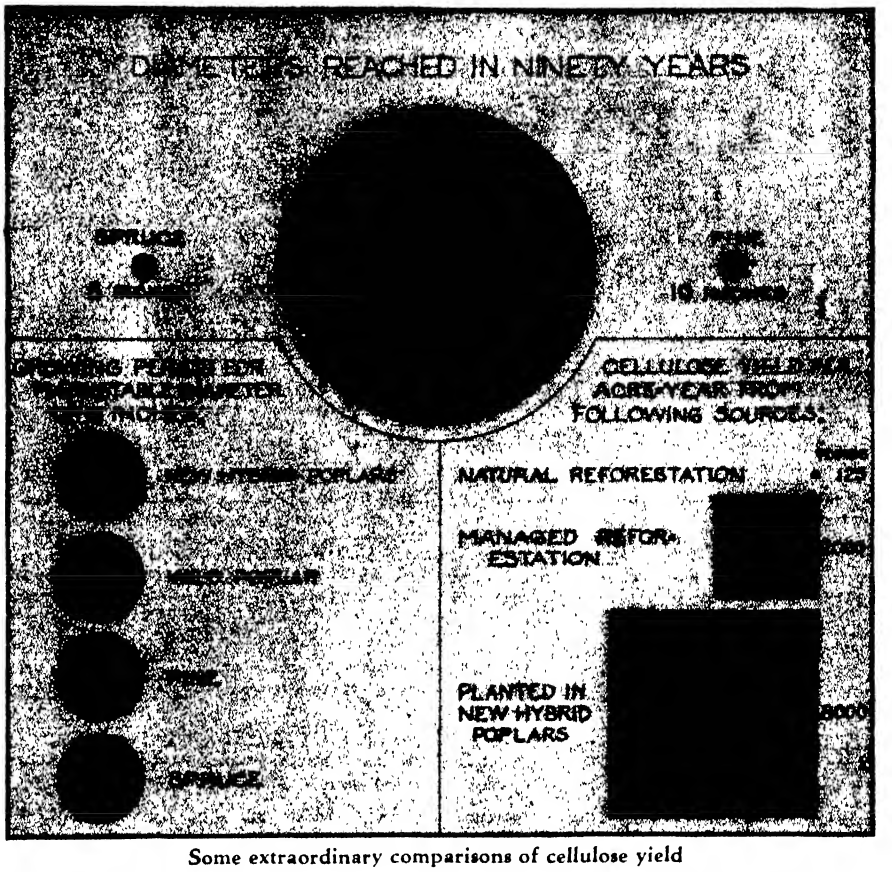
"By our cross breeding we obtained, all told, substantially 100 different cross combinations. During the years that the experiments have been carried on, we have grown well-nigh 16,000 seedlings; and out of these, virtually 100 of the best hybrids were retained for further study and for propagation by



cuttings. We thus ascertained that 25 types of trees were deserving of intensive cultivation. Eventually we shall probably find six or eight of these hybrids to be best suited for commercial planting on an extensive scale. Today, we have these poplars flourishing in Maine, New York, Florida, Wisconsin, and North Carolina—on a total of substantially 300 acres. In this way we are learning how these poplars adapt themselves to a considerable climatic range, and how they grow vigorously on wind-swept hilltops, on mountain slopes, and in the moist soils of bottom lands.

"INSTEAD of waiting 45 or 50 years, as is the case with the ordinary wild poplar, certain of our new hybrids can be cut profitably at the end of eight or ten years following planting. These trees increase in diameter at the rate of an inch annually. At the end of 12 years, an acre of these poplars should yield 80 cords of timber that can be used either for lumber or for pulp wood. They *grow from 10 to 14 times as fast* as the wild poplars that are now used in large quantities for pulp wood in the manufacture of what is known as 'book paper.' When nature unassisted retimbers a cut-over area, the yield per acre of pulp wood from poplars averages six cords, and it commonly takes about 60 years to attain marketable size.

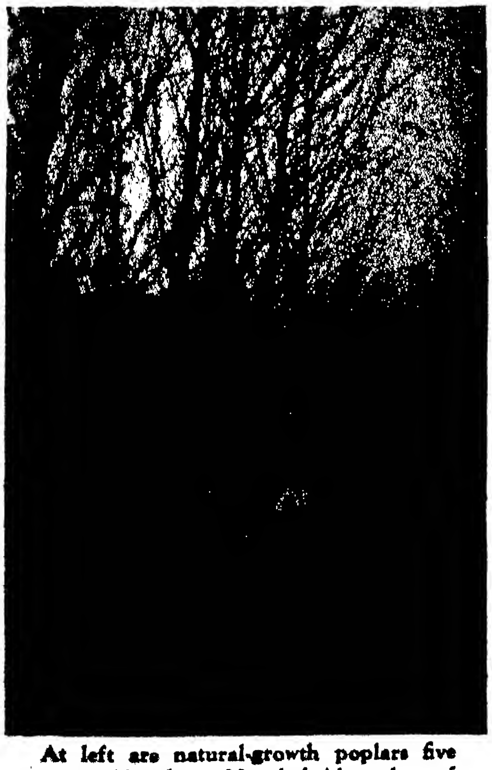
"Our calculations make it reasonably certain that more dollars per acre-year of wood can be grown than can be realized per acre-year in wheat or other farm crops. Cellulose plays an important part, and a steadily increasing one, in modern life. It is the raw material in the making of paper, textiles, explosives, and numerous other commodities that serve our needs in various ways. Cellulose will, undoubtedly, have wider applications in the years to come; and sources of cellulose may, therefore, be reckoned as potential wealth. In this particular, let us see how the new hybrid poplars measure in comparison with other sources of cellulose:



Some extraordinary comparisons of cellulose yield

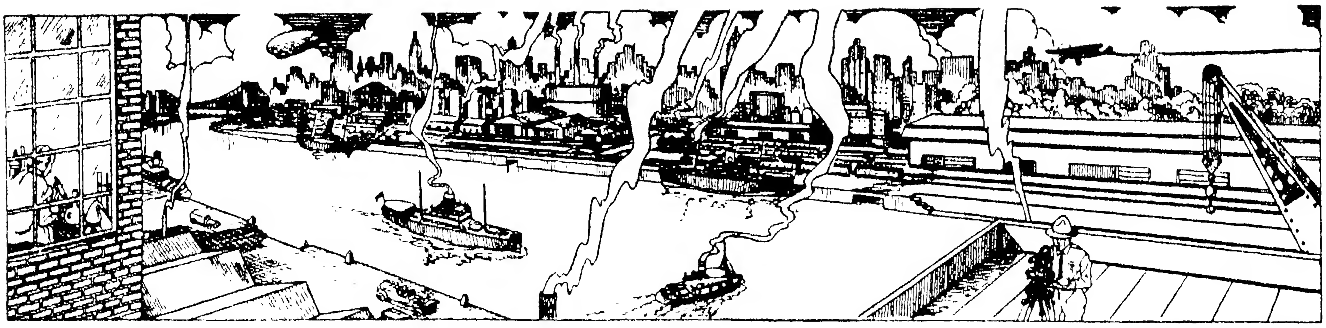
	Per acre-year
Flaxstraw	100 pounds
Cotton	150 "
Cornstalks	500 "
Reforestation Natural, best	125 "
Reforestation—Managed, pure species	2000 "
Reforestation—New hybrid poplars	8000 "

"Thirty years ago, pulp wood in America cost five dollars a cord delivered to our paper mills; and within the succeeding 13 years the price mounted to ten dollars a cord. During the past decade, pulp wood averaged 25 dollars a cord by the time it was at the mills. Undoubtedly, this raw material will fetch more as years go on. The new hybrid poplars thus offer prospectively a substantial source of relief, especially when used in making book paper, which is extensively employed in the publication of magazines. At the present time, our mills are working into paper about a million cords of poplar yearly, together with other suitable hard woods; and we obtain from Canada annually approximately 200,000 cords of poplar. Think what this would mean to our farmers in a few years if they could grow hybrid poplars for this purpose."


At left are natural-growth poplars five years old. *Above:* New hybrid poplars of the same age. The difference is striking

DOCTOR McKEE and his associates can now produce in four years a volume of nursery stock that would require a period of six years if generally accepted nursery practices were followed. The McKee poplars, as they are called, will make it surely profitable to plant what are commonly considered unpromising or waste areas; and these poplars need be harvested only when there is a market for them. The trees can be planted where they will greatly help to arrest soil erosion, which annually takes from farmers a toll of fully 200,000,000 dollars; while saving against loss through erosion, the hybrids will be gathering value from the very soil that they protect.

It is inevitable that these hybrid poplars will take their place in any broad plan of reforestation—something that must be adopted in this country. In these promising and extraordinary trees we have one more example of the rich rewards that can be realized through scientific research.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

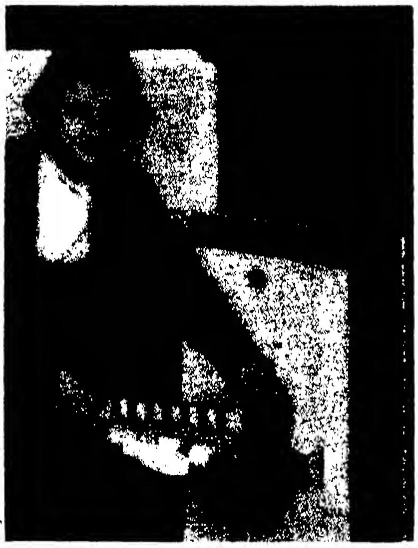
In charge, Daniel Guggenheim School of Aeronautics, New York University

A. E. BUCHANAN, Jr.

Lehigh University

Ejector Ice Cube Tray

ICE cubes that pop out of the tray as if propelled by some magical force are featured in the new Westinghouse refrigerators. The Eject-o-cube ice tray is one of many exclusive contributions incorporated in the new line of refrigerators designed to reflect the spirit of the present streamline age. Due to increased efficiency, a supply of cubes can be frozen in an hour's time.



Moving two levers ejects the ice cubes from this new type of tray

This new tray eliminates the necessity of pouring water over the tray to loosen the cubes, or following any other of the present tedious methods employed to secure the desired cubes. It also eliminates the waste in temperature and size brought about when the conventional method of securing cubes is followed.

By simply moving two levers upward and outward the entire supply of cubes is available, or as many as desired may be removed. The cubes are full sized, and the person wanting them suffers no annoyance in getting them out dry.

Other features of the new refrigerator are: a revolving shelf that permits greater accessibility to the stored foods and makes additional tall bottle space possible; an easy action "button touch" door latch; oversize froster with chromium plated door; triple storage compartment with separate drawers for salads, perishable foods, dairy supplies, and fruit; a seven-point dial temperature selector; and a handy tray that folds back on the inside of the door.

All models have the hermetically sealed unit that carries a five year protection plan.

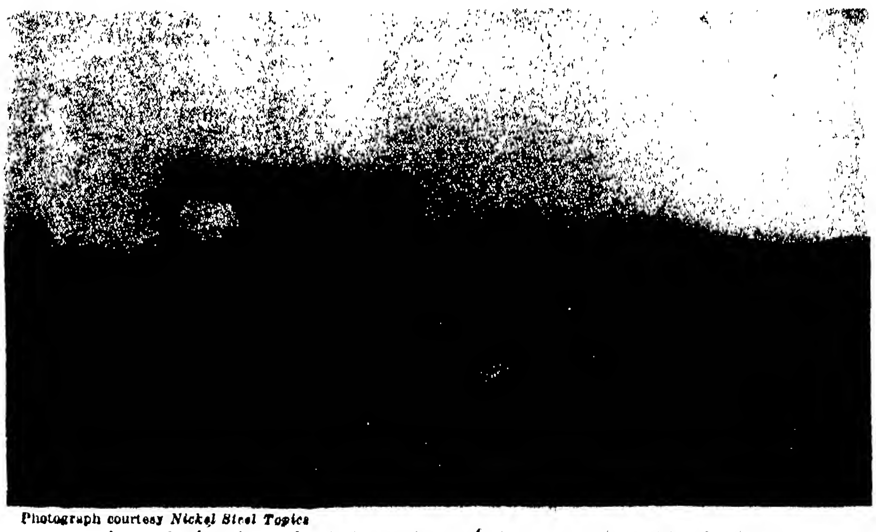
Wheeled Centipede in Africa

UPON the recommendations of the British Colonial Office, the Leyland Motors, Ltd., of Leyland, Lancashire, England, designed and built a new type of motor vehicle to solve the various problems involved in the transportation of heavy loads over the primitive roads and trails of Darkest Africa. This unit consists of a tractor and two trailers, each hauling a part of the maximum useful load of 15 tons. After being tried out over 5500 miles of unimproved roads in England, it was shipped to the African Gold Coast and in six months of 1933 covered 8050 miles with practically no trouble.

Each of the three components is mounted on eight wheels, all articulated, and all of the tractor wheels are driven, steered, and braked. This arrangement gives thorough steering control, as was demonstrated on a four-mile ascent in Africa with an average gradient of 1 in 20, the route having a continuous succession of hairpin curves. Both going up and coming down, even in the rainy season and under full load, this route was negotiated with ease and complete safety.

This tractor-trailer unit has been used to carry barrels of cement, concrete culvert pipes, timber, native products, and live stock. Its service was so satisfactory that the Leyland plant was called upon early last year to manufacture another one exactly similar except for the substitution of a Diesel oil engine for the Leyland six-cylinder gasoline motor. The net transport cost with the original unit was less than sixpence per ton-mile, and with the Diesel engine this is reduced about 20 percent. The Diesel-powered unit has recently successfully crossed Australia fully loaded.

In the performance of these vehicles, the use of nickel alloy steels plays an important part.



Photograph courtesy *Nickel Steel Topics*

An articulated 24-wheeled vehicle made for use in the wilds of Africa

Oxalic Acid from Corn-Cobs

THE lowly corn-cob, heretofore useful for nothing much but pipes, is a potential source of oxalic acid, according to Dr. H. A. Webber, of the Engineering Experiment Station of Iowa State College. Between 6,000,000 and 8,000,000 pounds of oxalic acid are used annually in the United States, according to Dr. Webber. It is used in laundries, in the production of Celluloid

and rayon, in the purification of glycerol and stearin, in leather manufacture, in tanning, in calico printing, in bleaching straw and wax, and in the manufacture of ink and dyes.—*A. E. B.*

RAT LEPROSY

MAN has nothing to fear from rats as carriers of leprosy, since the rodent disease is not true leprosy and is caused by a germ to which humans are apparently immune, according to Dr. Malcolm H. Soule, professor of bacteriology in the University of Michigan.

Asbestos in Bearings

A NEW bearing material which solves the problem of under-water operation, has just been announced by Johns-Manville.

A compound of asbestos, graphite, and rubber developed after several years of laboratory research and field tests, this material (slippery as its name implies) is a tough but readily-machined product which has a low coefficient of friction, even though unlubricated. Water is its best lubricant.

"Eel-Slip" material fills a long-felt need in industry for a bearing material which does not require use of the commonly employed lubricants and for numerous other uses where its mechanical strength, low coefficient of friction, increased efficiency in the presence of moisture and long wearing qualities make it unique.

In the paper industry, aside from bearings which run in water or under intermittent dry and wet service, Eel-Slip material

Asbestos-graphite-rubber bearing

is used for increased efficiency and economy on the wet end of Fourdrinier paper machines as shakers or flat screen blocks, water tables or forming boards, suction box covers, steam joints, suction couch and press rolls, and deflector strips and doctor blades.

PROGRESS In This Age Of Science

As Told to SCIENTIFIC AMERICAN

By FREDERICK H. ECKER
President, Metropolitan Life Insurance Company

LIFE insurance is based on actuarial science, which combines the mathematics of interest with the mathematics of mortality. It may seem strange to the layman to talk about mathematics of mortality, but mortality tables are developed by mathematical formulas.

As is well known, the probability of a person dying increases with age after infancy. However, it is desirable, in most cases, that the policy-holder pay the same amount of premium each year instead of an increasing amount. Hence a part of premiums collected in the early years must be set aside in a reserve fund which, with its interest earnings, will supplement the premiums received in later years to pay the claims which will then be incurred. The determination of the amount of yearly premiums to be collected, the part to set aside the reserve fund, and the amount of the necessary reserve at any given date is a definite function of applied actuarial science.

As is well known, compound interest is a powerful factor in the accumulation of reserve funds and the mathematics of interest is applied in various ways. To illustrate: it is an algebraic operation to determine the actual yield to maturity of bonds purchased either above or below par.

The mathematics of mortality includes the analysis of the number of persons living or dying during a past period in such manner that the future mortality among a large number of humans can be determined with a workable degree of exactitude. No man knows whether he will be alive a year hence—or ten years hence. But when humanity is considered in the thousands, the percentage of each thousand that will live or die each year

can be computed by the mathematics of mortality.

It is highly desirable that larger numbers of our population become insurance conscious. When this becomes more general, a person will not insure himself primarily with the thought of a lump sum in mind for the replacement of his economic loss to his family and to his dependents. He will insure himself with more consideration toward the thought of replacing his income with an income from the amount of insurance he carries. He will make such arrangements with the insurance company that this income will continue to be paid his beneficiaries over a number of years. When the great percentage of insurance is carried on this basis, the public will derive the greatest benefit from insurance and will have a truer concept of the science of insurance.

Rickets Fought for the Eskimos

THE New World, discovered and colonized by Europe 500 years before Columbus, was lost again because of rickets, modern archeological excavations in Greenland suggest. At Herjolfsnes, on the lonely Greenland coast, several skeletons of Viking women, disinterred and studied by Prof. F. C. C. Hansen of Copenhagen, exhibit severe pelvic deformations. The abnormalities are due to osteomalacia (rickets in its severe form), according to Dr. J. Preston Maxwell, British physician and professor of gynecology at the Union Medical College at Peiping, China. By inhibiting reproduction among the settlers, this disease changed the course of history, Dr. Maxwell suggests.

The Greenland colony was founded in 985 A.D., by Eric the Red. It was Eric's son, Leif the Lucky, who discovered "Vinland," thought to have been perhaps Massachusetts. The Greenland settlements lasted five centuries. An independent state at first, they finally became a Norse colony. Scandinavian ships maintained a busy commerce there, trading European wares for New World walrus ivory. Great stone churches were erected; cattle were imported; and new local industry began.

Clothing styles dug up by archeologists in Herjolfsnes show how close and continuous the European contact was for a while. Then, at last, for some mysterious cause, decline set in. The population died. Houses fell into ruin. Grass and willow grew over them. Finally Eskimos settled on the sites. The Norse ships stopped coming, no one knows when, or why.

The ruins and the buried objects tell their strange and tragic story, and the deformed bones, perhaps the reason for it. Did the even-then-proud Nordics refuse to take the native cod-liver oil which has enabled their despised Eskimo neighbors to survive to the present day?—*Science Service.*

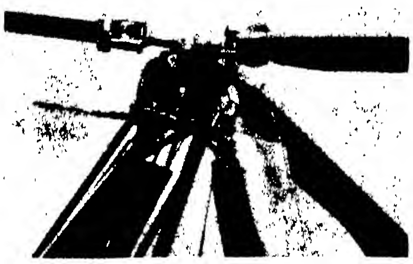
The "Crown Jewel" of the Aluminum Industry

THE cap of the Washington monument was examined with great interest by scientists when repairs to the famous landmark made it possible to inspect the aluminum pyramid. After 50 years service as a lightning rod, 550 feet above the ground, the metal that cost 12 dollars a pound when the monument was built showed no signs of deterioration. In fact, the engraved inscriptions on the sides of the pyramid were perfectly legible. Today aluminum sells for 21 cents a pound, but when this cap was made, the metal was such a curiosity

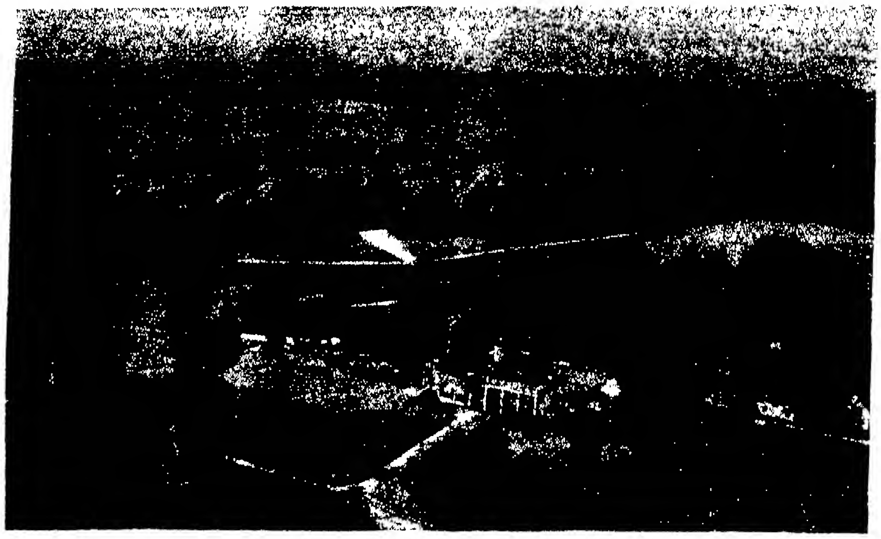
that the cap was exhibited in the window of Tiffany's and people shook their heads dubiously at the new-fangled metal and doubted whether it would stand up under the severe conditions of weathering to which it would be exposed.—*A. E. B.*

The Wingless Autogiro

THE wingless Autogiro, originated some time ago by LaCierva himself at his British factory, has recently made its appearance in the United States in two machines, one built by the Autogiro Company of America, and the other by the Kellett Autogiro Corporation. Previously, the Autogiro carried a fixed wing at the ends of which were placed conventional ailerons. Rudder and elevators were also employed,



Upper end of the rotor support pyramid in the new wingless Autogiro



The wingless Autogiro in flight over Mt. Vernon

and the controls followed those of a conventional airplane. The rotor system was four-bladed.

In the new wingless Autogiro, direct control is obtained by inclination of the entire rotor system, which is so mounted as to pivot on a species of universal joint, and which can be tilted either fore-and-aft or laterally. As a result, the fixed wing has been eliminated, and neither ailerons, elevators, nor rudder are employed.

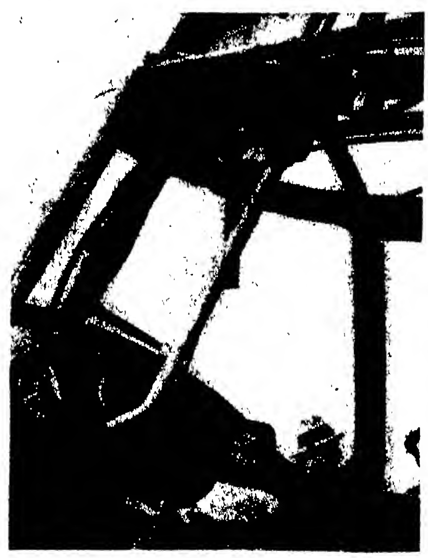
A remarkable improvement in performance has derived from the invention of the direct control. Previously there were two lifting systems—the freely rotating or "autorotating" rotor and the fixed wing. These two lifting systems carried varying proportions of the load but always involved aerodynamic resistance. Now but one lifting system, the rotor, is there to create air drag and hence the aerodynamic efficiency has been greatly improved. This improvement in aerodynamic efficiency is further enhanced by the substitution of three blades for the four of earlier practice. (The dynamic balance with three blades is, incidentally, just as good as with four blades.) The elimination of the fixed wing has reduced the structural weight, and structural weight, as we know, is the constant concern of the aircraft designer. The Autogiro has always had remarkable landing characteristics and a low take-off speed. It was not so satisfactory in top speed except with excessive application of power. Now an extraordinary speed range (that is, ratio of top speed to minimum speed) of approximately 6 to 1 has become available.

The specifications of the wingless Autogiro built by the Autogiro Company of America illustrate this improvement in performance:

Engine 80 horsepower Pobjoy, five cylinder radial.
Top speed 100-105 m.p.h. (approximate).
Cruising speed 90 m.p.h.
Take-off speed 25 m.p.h.
Minimum speed 17 m.p.h.
Weight empty 600 pounds.
Gross weight with pilot, passenger, and fuel and oil, 1140 pounds.
Fuel 17 gallons.
Range 350 miles.
Rotor diameter 32 feet.
Over-all length (blades folded) 20 feet 10½ inches.
Over-all height 8 feet 3½ inches.
Landing gear tread 6 feet 5 inches.

It will be noted that this machine, with a slightly more powerful engine, would have successfully met the requirements of the recent Department of Commerce competition for low power planes, and shown itself well adapted to the needs of the private owner and amateur pilot.

The machine features a comfortable two place, side-by-side enclosed cabin which is entirely suitable for private ownership. Another practical advantage from an owner's point of view lies in the ability to fold the wings. The over-all length of less than 21



Interior of 'giro cabin; note inverted control column with hand grip

feet is then quite moderate, and the width of the storage space is no longer determined by the span of the fixed wing or rotor diameter, but by the span of the tail surfaces which is only eight feet.

The perfect control available under all circumstances by the introduction of the tiltable rotor is perhaps even more important than the improvement in performance. Direct control being achieved by the tilting of the rotor, and the 'giro lifting system

Rear view of wingless Autogiro, showing steerable tail wheel

Piled in front of this Eastern Air Lines plane are emergency repair parts which were recently rushed from Newark, New Jersey, to an oil refinery on the island of Arubia, Dutch West Indies, a distance of 3000 miles. Three weeks were saved by sending these parts by air, and the 808 pounds which this shipment weighed made it the largest single international air-transport express shipment to date

being utterly immune to side-slips or possible spins, it is sufficient to push the stick in the direction in which one wishes to go and the 'giro follows. While the American wingless has a rudder, we are informed that the use of the rudder may be dispensed with in all normal flying. There is no coordination of aileron and rudder to be acquired, and turns, climbs, and other normal maneuvers can be readily acquired by the novice.

Since control is not dependent on the forward speed but on the manipulation of the main lifting element itself, the 'giro can land substantially vertically or at least with a forward velocity of only 10 or 15 miles per hour and still be under full control. Take-off is simplicity itself. With elimination of the fixed wing it is not necessary to get the tail up to gain speed. In a normal take-off for the wingless ship, the tail remains on the ground until 25 m.p.h. is reached. To take off it is not necessary to change the attitude of the fuselage, but merely to increase the incidence of the rotor by tilting it back. On landing, in the words of "Pontius," writing in the London *Flight:* "Get over a point just short of the petrol (gasoline) pump or hangar door, and come straight down, nose well up, and in absolute control, to, say, 150 feet. Then gain a trifle of speed by easing the nose down, and when you are there, pull the stick back, when you will sink a few feet and stop in your own length." There are still certain rules to observe as in revving up on the ground, waiting till the rotor has reached the right speed, and so on, but these are simple and easy to learn.

The general appearance of the wingless Autogiro is well illustrated by the photographs. The cabin has windows at front, sides, top, and rear; with no fixed wing the vision is well nigh perfect. The construction of fuselage and landing gear follows that of the conventional airplane. The landing gear tread is somewhat less than that of previous Autogiros; the lateral control is so perfect that very wide tread is not essential even at very low speeds. The rear view shows a steerable rear wheel, a stabilizer, and no elevator, and fins without rudder. The stabilizer has on the right side a positive camber and on the left a negative camber. This to take up the engine torque, which formerly was taken up by suitably rigging the fixed wing.

We cannot conclude this note without mentioning one experiment which has been successfully made with the 'giro in England, and is about to be tried in the United States—an absolutely vertical initial climb of some 75 feet or so. This is achieved by the use of controllable pitch blades. The pitch is at first made quite small or flat and the blades are turned up to their highest speed by the starter system. Then the clutch is disengaged and at the same time the blades are moved to their highest pitch. They are therefore rotating with the very high speed of low pitch, and meeting the air at a high lift angle. Naturally the lift of the rotor becomes very high, and the craft rises vertically in the air.—*A. K.*

Clipper "No. 7"

WHILE the Sikorsky *S-42* already in service on Pan American Airlines is adding to its reputation, and the second of the Sikorsky Clippers is nearing delivery, Pan American Airways are accepting another huge ship, Clipper *No. 7,* from the Glenn L. Martin Company.

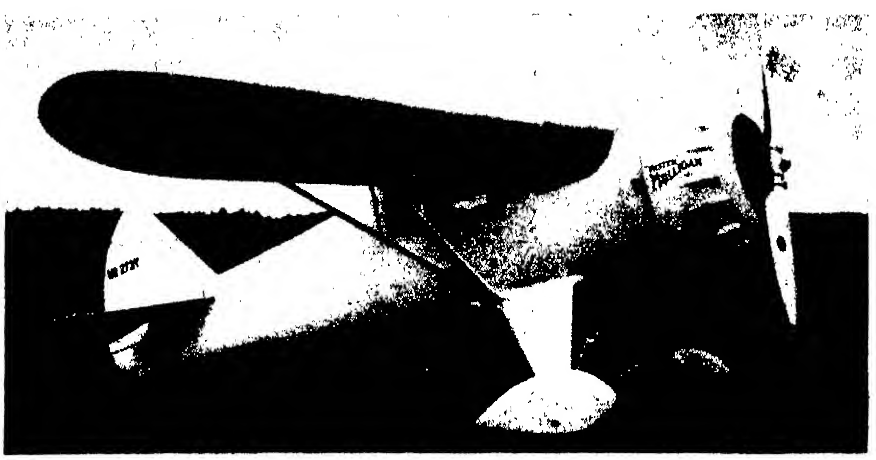
Clipper *No. 7* is specifically intended for experimental operation in the Pacific, is the largest American airliner ever built, and is of tremendous significance from the point of view of over-ocean operation. Like the *S-42,* which we have described fully in these columns, the Martin Clipper was designed and built in the greatest secrecy. Successful acceptance flights have lifted the veil of secrecy somewhat, although many of the characteristics of the new flying boat are still being withheld.

Nevertheless it is possible to draw some comparisons regarding the efforts of the two design groups. The Martin Clipper is somewhat larger and heavier than the *S-42.* The span is longer and the wing chord is wider, reaching 20½ feet at the root of the wing. The engines employed are double row Wasps developing 800 horsepower, while in the Sikorsky four single-row Hornets of over 700 horsepower each are employed. The Sikorsky engineers, making skilled use of rear flaps for lift increase, loaded their ship up to 28 pounds per square foot, and were fully justified in so doing. The Martin group was more conservative, and only used a loading of 22 pounds per square foot. After the results of the Sikorsky tests there is no doubt that the higher loadings will now be quite acceptable for large flying boat practice.

In the Sikorsky, twin rudders are employed, disposed towards the end of the stabilizer. This means that the rudders are always under the influence of the propeller stream. The Martin engineers disregarded the slip-stream effect, and used a single huge rudder at the end of the hull. Such a rudder arrangement probably means saving in weight and head resistance. The Sikorsky design provided for strut bracing carried out quite far on the wing, to secure lightness of wing structure. In the Martin, the top ends of the bracing struts are not so far out.

The most striking difference lies in the flotation system. In the Sikorsky Clipper, wing tip floats are braced from the wing and disposed towards the tips. In the Martin boat, wing tip floats are dispensed with and sponsons or water wings projecting from the sides of the hull are counted upon to give lateral stability when in con-

Clipper *No.* 7, to be used for experimental operation over the Pacific



Mister Mulligan, **pride of Benny Howard's private life**

tact with the water. Tip floats probably give more head resistance, but many authorities believe that they give better water stability characteristics and that sponsons cause difficulties in turning the boat while in the water.

Comparisons aside, the Martin design is a splendid one, from every point of view. The use of 24 ST—the strongest modern aluminum alloy—is a step forward. Metal covering is used practically throughout. The arrangements for passengers, crew, and the equipment are complete and carefully thought out. Oil driven turbine pumps are used to transfer the fuel from the hull to the engines. The landing speed is low in spite of the absence of floats, as the wing loading is less than in the Sikorsky boat. While actual performance figures are still not available we are informed that they will closely approximate the following:

Gross weight, 51,000 pounds; weight empty, 23,100 pounds; wing span, 130 feet; chord, 20½ feet at strut point; over-all length, 89 feet 6 inches; over-all height, 24 feet; wing area, 2170 square feet; Power plant, four double row Wasps geared down and supercharged, developing 800 horsepower each and driving three blade, automatic controllable pitch propellers; top speed about 180 miles per hour, cruising speed 163 miles per hour.

The Martin Clipper will be able to carry 14 passengers and 2000 pounds of mail for 3000 miles non-stop. With its full passenger complement of 53 it will have a non-stop range of 1200 miles. With mail load only, the range will be 4000 miles.

Great attention has been paid to sound proofing. With geared down and rubber mounted engines, with sound proofed cabin, and exhausts carried back above the thick wing, the decibel noise level in the cabin will be only 72—the level of a Pullman compartment on a straight railroad track.

The Glenn L. Martin engineers and the Pan American authorities are to be congratulated on the co-operation and skill which have given this admirable addition to American aviation achievement.—*A. K.*

The Private Life of Benny Howard

WHAT is the private life of a transport pilot who, like "Benny" Howard, flies the huge airliners of United between New York and Cleveland with perfect regularity and freedom from accident? Mr. Howard's private life consists in spending all he can save from his generous pay in constructing racing planes which lead in this field. One of our photos shows *Mister Mulligan*, the latest product of this practical flyer, original constructor and serious student.

Mister Mulligan was intended for the Trans-Continental Bendix Trophy dash. A flight at 20,000 feet without oxygen led to grogginess, a forced landing, and an unpleasant mishap, which prevented the participation of *Mister Mulligan* in this transcontinental dash. The fact remains, however, that this new ship, fully equipped for private flying, with dual controls and four occupants, powered with a supercharged Hornet engine, has a top speed of 290 miles an hour, and is probably the fastest cabin plane the world has ever seen.

What we admire in this beautiful ship is the logical idea of streamlining, carried to the extreme of the art. The huge cowl blends into the fuselage, the fuselage flows with perfect smoothness into the wing, fittings and struts are all hidden. Even though plenty of power is available for *Mister Mulligan* and the wings are small in area, this ship still remains a fine example of applied aerodynamics.—*A. K.*

NIGHT FLIGHTS

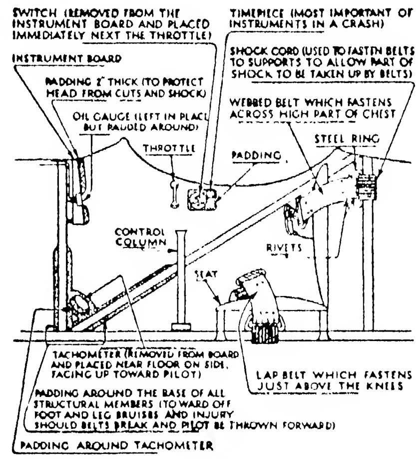
SIXTY percent of Eastern Air Line's flying is now done at night. Two daily round-trip eight-hour passenger, mail, and express schedules are flown between New York and Miami and an eight-hour 50-minute schedule between Chicago and Miami on the first direct transportation route between these two areas.

"I Am Still Alive"

THE book with this intriguing title, by Dick Grace, is a thoroughly well written and exciting account of the experiences of a man whose hazardous profession is crashing airplanes for movie "thrillers." The adventures of Mr. Grace make exciting reading, but the book also carries serious lessons for the aviation constructors.

In preparing for crashes Mr. Grace soon decided that to use a steel suit of armor was wrong in principle. A severe blow from a flying propeller might cause the plates to squeeze together with danger of piercing the body and retarding rescue. Besides, an armor-plated suit would be intolerably clumsy and heavy. He came to the conclusion that a better plan was to design the cock-pit in such fashion that the entire airplane might be wrecked and still leave one section of the fuselage, that in which he sat, intact. Mr. Grace has been able to do just that. The pilot's motor has broken through the gas tank in front of him and the controls have been broken and destroyed in back, the wings and landing gear have been scattered, but he has been able to keep most of the débris from striking him and to have a cock-pit around him when he finished!

The diagram, reproduced by courtesy of Rand, McNally Company, illustrates the final design of the cock-pit. An arrangement of webbing is fitted high under the pilot's armpits; when the central safety clasp is locked it pins the pilot to the very back of the seat so that only the slightest movement is possible and it is difficult to take a deep breath. A lap belt fastened just above the knees adds to the voluntary imprisonment. All instruments are either removed out of harm's way, or are carefully padded. There is padding around the base of all structural members. Even though the daredevil has broken his neck on one occasion, such an arrangement of cock-pit may have suggestions for our designers.

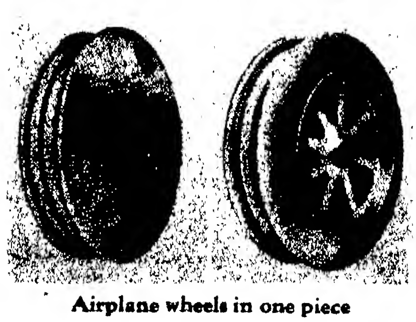


Injury to a "stunt" pilot is prevented by this cockpit arrangement

Equally interesting is the deliberate and careful way in which the precise method and location of crashes are worked out.—*A. K.*

A Single Piece Airplane Wheel

THE Palmer Monodisk Wheel, a British invention, attracted favorable attention at the recent Paris Aero Show. The structure of the wheel consists of a single casting of magnesium alloy. Because the wheel is produced in one casting, no bolts, rivets, or nuts are used. The sides of the disk are fashioned with integral webs, and are thus



Airplane wheels in one piece

load carrying members. The benefits of the design from a maintenance point of view are evident. For the same strength the monodisk wheel showed a weight reduction of 28 percent compared with conventional built up wheels. The use of the casting also enables the wheel to be given a fine streamline form, important from an airplane performance point of view.—*A. K.*

EXPANDING AIRLINES

PERHAPS the greatest benefit of an expanding airline program during the past year has accrued to American business groups interested in developing Central and South American markets. New fast daily schedules from New York and Chicago to Florida make direct connections with planes to all South American points.

Details of the airmail pick-up described on this page

Airmail Pick-Up

SEVERAL years ago we described the Lytle S. Adams system of airmail pick-up and delivery. Since then Dr. Adams has made important improvements and installation of the system is under favorable consideration for the huge new Chicago post office at Van Buren and Canal Streets, which fortunately has a vast flat roof. The plans call for an airplane shuttle service between the Chicago Municipal Airport and the new post office, which will reduce the time of delivery of letters between these two points to six minutes. There is no doubt that the incorporation of such shuttles in our transport systems would speed up service and increase the popularity of the airmail.

The main element of the Adams' device is a huge metal chute with a wide entrance narrowing down to a small slot. The chute is so mounted, either on a flotation system on water, or on rollers running on a track, that it always heads into the wind. Since airplanes when landing or taking-off head into the wind, this weathercock feature of the apparatus is essential.

The incoming mail bag, suspended from the airplane at the end of a cable, enters the wide mouth of the chute. The contact cable is guided to the narrow slot at the end. The mail bag makes contact with a smooth slide. When a ball enters the socket at the extreme end of the chute, a fragile connection is broken and the mail bag is released and slides downwards to the floor of the chamber. At the same instant a spring trigger actuated catapult shoots another mail bag outward in a species of bucket or basket. The end of the suspended cable makes instantaneous connection with the hook connected to the outgoing mail, and in an instant mail has been delivered and picked up. The catapult which brings the outgoing mail up to speed lessens the shock on the airplane cable, but a shock absorbing system is nevertheless provided at the point where the cable is attached to the airplane.—*A. K.*

Carbureter Ice Formation

COLD weather flying is becoming much more popular. In the early years of air transport, the volume of passenger traffic used to fall off abruptly as soon as cold weather set in. Nowadays there is scarcely a drop in the curve when winter comes.

But cold weather flying brings to the fore a most difficult problem, that of ice formation in the carbureter. When there is enough moisture in the cold air, ice may be readily formed in the fuel induction system and all the passages may be clogged up. The most effective cure is to preheat the air entering the manifold system. The Phillips Petroleum Company is undertaking the study of the problem in the most scientific fashion.

A Lockheed Orion has been completely equipped for the research. Systematic temperature measurements will be made with small iron and constantan wire thermocouples. Three thermocouples are installed at various points of the carbureter Venturi. Others are located in the carbureter bowl, and before and after the supercharger. At the same time various types of air preheaters can be investigated.

The purposes of the research will be two fold. One will be to determine the atmospheric conditions under which ice formation is to be most feared. The other aim will be to determine the best preheater and the amount of preheating required. To raise the temperature of preheating too much will, of course, mean a loss in volumetric efficiency and power of the engine.

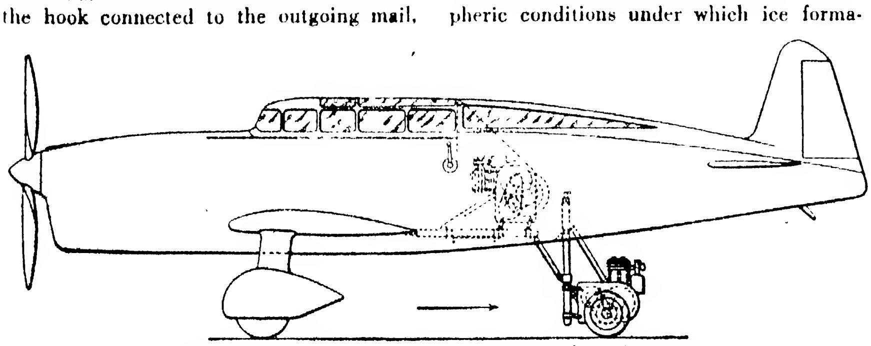
The experiment will be very valuable for general aviation operation and will also help engine and carbureter designers.—*A. K.*

An Airplane-Automobile

PARISIANS like to loaf on the streets of their beloved city, and, when seated at sidewalk cafés are often rewarded by curious sights. Certainly the appearance in the streets of Paris of the Caudron airplane-automobile must have attracted considerable attention. The airplane is entirely conventional in character, and the wings are made to fold back along the side of the fuselage after a manner which is well known in the United States.

The novel feature of the "Aviocar," as the strange vehicle is called, lies in a small air-cooled engine mounted in the rear on a third wheel. This little motor is provided with a change-speed gear and one or two other items which we generally associate with a motor car. With the aid of a retracting mechanism, cable operated, and not different from an ordinary amphibian gear, the small auxiliary motor and the third wheel disappear in the bottom of the fuselage. The wings are unfolded, and behold, the automobile-airplane is ready for flight!

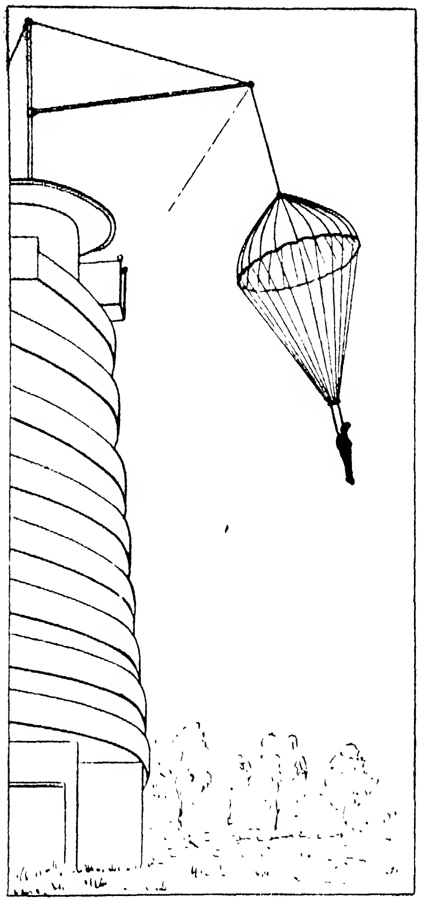
Granted that the additional mechanism can be kept within a reasonable weight, and that certain obvious mechanical difficulties are overcome, we see no reason why some day such a combination should not be practicable for general use. Of course, to develop such a "gadget" until it is entirely satisfactory will mean a good deal of patient mechanical work.—*A. K.*



The airplane-automobile carries an "outboard motor"

Teaching Parachute Jumping Safely

THE first parachute jump that a man makes is apt to test the strongest nerves, and it is on the very first jump that a student is most likely to make a fatal mis-



A safe method of parachute jumping instruction developed in Russia

take of some kind or another, particularly in pulling the rip cord.

The Soviet aviation authorities have introduced a new wrinkle in this exciting art. A special device mounted at the top of a tall building holds the parachute open and only releases it when the student is ready for the drop. In this manner he at least becomes accustomed to the sensation of the jump.—*A. K.*

Stout Announces New Type Automobile

AN entirely new type of automobile which discards all previous traditions and conceptions generally used as the basis of car design, is announced by William B. Stout, President of the Stout Engineering Laboratories. This new car has been under development by Mr. Stout for several years and preliminary models have been undergoing actual road tests for the past two years.

According to the designer this new car marks the first real departure of the automobile from its classification as a development of the "horseless carriage" which initiated the present type of automobile design. The new vehicle is no longer in overall length than the present type of car and yet incorporates a tremendous gain in interior roominess and, in addition, is also claimed to have added superiority in riding comfort and performance.

Because of its general shape the car has been tentatively named the Stout Scarab because of its resemblance in form to the classic Egyptian beetle. It is not streamlined in the sense usually used as a means of reducing drag at high speeds; but is shaped to facilitate easier steering in all directions of wind. It has been found by careful investigation that this is a far more important factor in roadability than generally realized, while gains in speed or fuel mileage as a result of streamlining in an automobile are negligible at usual road speeds.

The engine in this car is at the rear. It takes up no more than the space of the usual trunk rack. Since the engine is housed away in the tail of the beetle shape, the usual hood space up front—all the way to the point corresponding to the radiator ornament of the ordinary type of car is available for passenger room.

Controls are all conventional as to gear shift, pedal location, steering gear, and so on, although a power-brake is standard equipment, eliminating most of the work necessary in applying the brakes on the usual car. To the engineer it will be illuminating to state that the support for the body is materially above its center of gravity. Since this is the case the car tends to pendulum and "bank" on the turns. This method of support eliminates all tendency of the car to roll even on sharp corners.

This peculiar side stability plus the use of a very sensitive spring suspension eliminates all quick road shocks. The spring suspension itself consists of an airplane landing gear on all four wheels including coil springs with large oil cylinders to absorb shocks.

The manner of weight distribution is based on the idea of providing easier steering by removing some of the weight from the front axle. Also to improve the ride, additional weight is placed over the rear axle. Both of these have been accomplished by placing the engine in the rear. This also results in greater traction. It is, furthermore, of marked assistance in braking because of the reduction in the amount of weight transferred to the front wheels in stopping at high speed. This greatly reduces the tendency to skid and for the car to "dive" as is so often the case where the load is concentrated heavily over the front axle. Other advantages claimed for the rear location of the engine are the elimination of engine noise and odor.

The engine is a standard V-8 of 100 horsepower driving through a selective gear mechanism to the rear axle. Because of the lightness of the car the axle ratio is more nearly direct than usual, contributing toward smoothness, speed, and economy.

It is the plan of the Stout company to build one hundred of these cars during the coming season. The production is to be limited to this figure and the cars are to be placed in the hands of selected representative owners in various parts of the country.

HIGH OCEAN BED

THE deepest hole in the ocean, Emden Deep near the Philippines, is very little closer to the earth's core than is the top of high Mt. McKinley in Alaska. This seeming paradox is due to the well-known fact that the earth is not a true sphere but bulges somewhat at the equator and is flattened at the poles.

Silver as Material of Construction

SOLID silver apparatus in the chemical plant has progressed far beyond the stage of a novelty. At first thought, it seems hard to believe that the large vats and tanks in acid, perfume, photographic film, and dye plants are lined with sheet silver of a high degree of purity but when it is realized that the cost of silver is comparatively low these days and that the metal has ideal properties for certain uses, we begin to understand that the precious metal has

The new Stout "Scarab" motor car with rear engine mounting and a body designed to facilitate easy steering

The interior of the "Scarab," showing the roominess of the body. The gear shift and other controls are conventional

grown into many utilitarian applications.

Silver may be used in most industries where corrosion takes place owing to attack on base metals by the acids involved. Silver is attacked by nitric and hot sulfuric acids, but its resistance to the organic acids makes it especially suitable for food manufacture where corrosion has the additional effect of food contamination. Among the food products for which silver is advantageous are jams, pickles, vinegar, essences and cider. Other plants for which silver is in demand includes those used for acetic acid, scent, photographic emulsions, aniline dyes, general chemical production, and ink.

In vinegar and acetic acid plants, condensing coils and stills are made of silver, this metal being especially recommended for use in the distillation of white vinegar, where copper has been found to cause discoloration.

Plants making scents, essences, photographic emulsions, aniline dyes, and general chemicals find that pure silver apparatus is usually best adapted to their requirements, but occasionally copper and nickel pans or troughs are lined with the metal. Ordinary ink has a very corrosive action on base metal with which it comes in contact, and silver has been found to give good results when used to line many of the essential parts of machines for filling ink-bottles. *A. E. B.*

WHAT—ANOTHER?

A NEW "ology" has made its appearance. "Phenology" has been coined to indicate the study of flower-blooming time and fruit-ripening time. The study appears to be quite important, especially in the rehabilitation of depleted grasslands for grazing.

Self-Sealing Wrapping Paper

THE tremendous vogue of Cellophane has focused interest on wrapping materials that make an attractive appearance, and, at the same time, protect the contents of the package from moisture and contamination. There has now appeared on the market a new wrapping material known as "Parafilm," which is flexible, elastic, waterproof, and self-sealing. Being opaque, it does not compete directly with Cellophane, but opens a new field where a bright, glossy, and rugged wrapping is desirable. [Another new type of flexible wrapping material was described on page 32, January, 1935.—*Editor.*]

This new product is made in sheet form, cut to various widths, and marketed in rolls. According to Arthur D. Little's *Industrial Bulletin*, it has remarkable resistance to both water and water vapor from high humidity atmospheric conditions, making it suitable for protective coverings of materials to be stored in a moist atmosphere. The sheet is thermoplastic, sealing to itself or to other surfaces with the application of a low degree of heat and pressure, giving a good bond. It comes in many attractive colors, and can be stretched to a considerable degree.

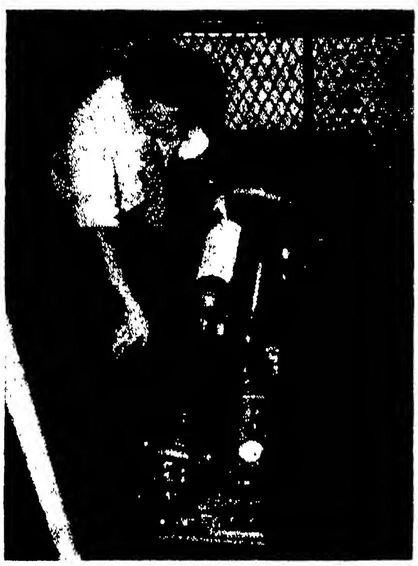
One of the first extensive uses to be made of this unique material is in the florist business, where it is admirably adapted for wrapping wreaths, flower stems, potted

plants, and so on. The attractive color combinations available, the ease of shaping, and the glossy surface appearance make it suited for the manufacture of artificial flowers. —*A. E. B.*

Improved Transmission of Photos by Wire

ALTHOUGH the actual transmission of photographs by wire is not at all new, recent developments have brought the subject very much to public notice. The Associated Press has inaugurated a system for the transmission and reception of photographs for newspaper reproduction. The technical advances which have made possible astonishingly good results are given in the following paragraphs. Those readers who have seen wired photographs reproduced in the past have undoubtedly noticed the complete lack of detail. Under the present system this tremendous handicap has been overcome and even portraits transmitted by the Wirephoto process, as it is called, are, when reproduced in newspapers, practically as clear as a reproduction made from an ordinary photograph.

In the Wirephoto system, a positive print wrapped around the sending machine cylinder is scanned in strips 1/100 of an inch wide by means of a light beam focused first on a light valve aperture similar in all respects to the light valves used in sound picture work. The light valve chops the beam at a frequency of 2400 cycles, passing a pulsating beam which is turned through ninety degrees to focus sharply on the surface of the picture.



Wirephoto transmitter: A picture is in place on the scanning drum

The light beam travels horizontally at an inch a minute. The cylinder, rotating at 100 revolutions a minute, is approximately 12 inches in diameter, thus giving a scanning area speed of more than eleven square inches a minute.

Since the light reflected from the picture surface is proportional to the tone density of the surface, the pulsating beam is thereby modulated with the tone values of the picture before reflection to a photocell of the gas-filled cesium-oxide-on-silver type.

The optical system is made up of a condenser lens to focus the beam on the light valve aperture and an objective for focusing the pulsating beam onto the picture surface. Turning through 90 degrees is accomplished with a small stainless steel mirror, and parabolic surfaces, also of stainless steel, gather reflected light from the picture for passage to the photocell.

The light valve itself is an aperture 0.01 of an inch square with two parallel duralumin ribbons, 0.006 of an inch wide and 0.0005 of an inch thick, partially covering it and connected at one end to form a loop. A magnetic field at right angles to the plane of the ribbons, furnished by two permanent magnets, and a 2400-cycle current through the ribbons furnish the shutter action. As the ribbons vibrate on their inward swing the aperture is closed, and on their outward swing the aperture is opened.

The principle of operation of the receiving light valve is similar to that of the sending light valve except that only one ribbon is used. It is caused to move by the varying direct current representing the tone variations in the picture, and not by a constant frequency. This ribbon is tuned to the rather high natural frequency of 1200 cycles, and suitably damped so that all movement of it is forced vibration caused by the incoming picture signal. In this ribbon circuit is a tuned equalizer which prevents unwanted or transient vibrations.

By varying the side motion of the receiving light valve ribbon, the opening through which the light reaches the film is varied proportionately, thus obtaining film exposure in exact proportion to the original tone values of the print on the sending machine. This light beam is adjustable in width, so that the exposure lines may be made to merge and be practically invisible on the finished print.

The scanning of the negative is exactly at the same rate as the scanning of the print by the sending machine, the cylinders rotating at the same speed and the beam moving horizontally at the same rate. After the negative is completely scanned it is removed to the dark room for developing and printing.

New Light Outboard Motor

A NEW outboard motor that develops 1½ brake horsepower at 3500 r.p.m., ample to drive commonly used rowboats, fishing boats, and so on, at speeds of five to seven miles an hour maximum, has just been announced under the name of the Sportsman Single. The motor weighs only 24½ pounds, which is just about ⅓ the weight of Ole Evinrude's first outboard, which developed only about 1 horsepower. Thus this new model symbolizes the tremendous development that has taken place in outboards since their inception 26 years ago, as well as marking the 26th birthday of the institution which carries forward the Evinrude as well as the Elto name.

24½ pounds; 1½ horsepower

The new Sportsman is not only the lightest of the new outboards, but it excels in practicability, for parts have been eliminated and simplified so as to procure utmost compactness. It is capable of extremely slow trolling speeds, and the flexo-rubber steering handle increases steering ease. Fuel consumption is trivial; the magneto gives a hot spark that assures quick starting. Tilt-up and stern angle adjustment features are standard.

Filter Removes Tooth-Mottling Fluorine

AN aluminum and sand filter that removes fluorine from water has been devised by Dr. S. P. Kramer of Ft. Thomas, Kentucky.

Fluorine in drinking water is the cause of a dental disease known as mottled enamel. The condition has become so serious in the southwest, where fluorine is frequently found in the water, that at least

Wirephoto receiver: Recorded picture is in the case, ready for developing

one town has changed its water supply and now obtains its drinking water from another source in order to protect the teeth of its inhabitants. At one time it was feared that the water impounded by Boulder Dam would prove useless because of reports of the high fluorine content of the Colorado River tributaries.

Dr. Kramer made a contact filter of river sand to which he added 2 percent by weight of powdered aluminum. He reports to the journal, *Science*, that this filter removes fluoride from a solution containing 30 parts per million of sodium fluoride. *Science Service.*

A VITAL INDUSTRY

ONE SIXTH of all persons engaged in wholesale, retail, and service trades depend upon the gasoline and automotive industries for their employment and wages, says the United States Census Bureau.

Service for Photography Fans

THE Photographic Society of America, which is the recent expansion program of the Associated Camera Clubs to extend service to those interested in photography whether they be members of clubs or not, will begin its second year by publishing its bulletin in printed form with a few excellent illustrations. The society is also planning a national meeting in April, at the time of, and in conjunction with, the Pittsburgh Salon of Photography at Pittsburgh. Those interested in the work of this organization may address its secretary, B. H. Chatto, 1300 Milton Avenue, Pittsburgh, Pennsylvania.

Sulfur as a Lubricant

SULFUR has been found to make an ideal lubricant for metal cutting and machining operations. The machineability of a metal is more affected by the cutting lubricant than by the material of the cutting tool. Hence, it is obviously important to use an efficient lubricant. At the temperatures usually prevalent in modern machine-tool practice, oil is not a lubricant, although it is useful for its cooling effect on the metal work.

Probably the best machining lubricant which could be used is molten sulfur because it is a viscous fluid at temperatures which destroy the lubricating properties of lubricating oils. The use of molten sulfur for such a purpose is obviously impractical, but the Thomas and Hochwalt Laboratories, Inc., of Dayton, Ohio, have developed a material which accomplishes the same result. They call this cutting fluid "Sulflo," and it consists of the stable suspension of finely divided sulfur in petroleum oil. Sulflo is a moderately thin oily yellow fluid in which the sulfur particles are large enough to be seen with the naked eye. The use of this sulfur lubricant permits metal cutting machines to be operated at higher speeds, greatly increases the life of tools, and gives better finish to the product.

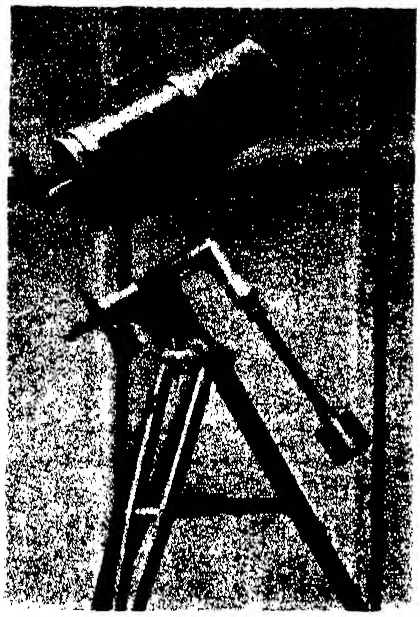
The action of Sulflo as a cutting fluid depends upon a peculiar property of sulfur not possessed by oils—namely, an increase of viscosity with a rise in temperature from

(*Please turn to page* 159)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

THE average amateur telescope maker finds the common Newtonian type of instrument satisfactory but, as a number wanted to make Cassegrainian telescopes, Russell W. Porter accordingly wrote, for the instruction book "Amateur Telescope Making," a chapter entitled "How to Make a Cassegrainian." He stated, however, that



The Lower 7-inch Cassegrainian

he had found the Newtonian the better performer of the two, and so, he added the subtitle, "And Why Not To," beneath the title named above. As he anticipated, this bit of discouragement has had the effect of causing many workers to tackle the job, after spitting on their hands and sticking out their chins, and with widely varying results.

One such job was done by Harold A. Lower, co-author of "Amateur Telescope Making," and his father, Charles A. Lower. Both are skilful old hands at the amateur telescope making art. Lower, junior, writes from 1032 Pennsylvania Street, San Diego, California: "I enclose a photo of the latest member of the Lower family, a seven-inch portable Cass. This little instrument is shielded for daylight use, and performs in daylight just like a refractor. While the optical surfaces are not perfect, I believe the errors do not exceed the theoretical limit for good results. At least, the performance is quite good, as it will stand up well with a one fifth inch ocular and will resolve doubles as close as one second of arc. The grinding, polishing, and figuring of this scope were done on a machine. We just wanted to see whether we could make it without any hand work on the mirrors, and we did. I rather believe that the difficulty of figuring short focus mirrors has been exaggerated, as we had no trouble with this one, although the primary mirror is $f/2.7$."

We asked the Lowers to send us a drawing of the layout and this is also reproduced on this page. As they state, the shade tubes, shown in heavy line, are the main feature. The primary mirror is held in place by a collar on a short tube which extends through the perforation in it, and the shade tube screws fast to this.

We also show a photograph of the twin Lower telescope, a 12-inch Cassegrainian of $f/18$ and a 12-inch Newtonian of $f/4.5$, mounted on the same axis. A little coop mounted on wheels rolls forward and covers the two tubes and their mounting when they are not in actual use.

"When we mounted the new instrument," Harold Lower writes, "we compared the new and the old silver coats, and found that the Cass, which had been silvered 10 months, was almost as bright as the new one. That proves that the can of caustic soda which we place in the telescope on closing it up has really helped to prevent tarnishing of the silver. Before we started using the caustic soda, the mirror would be badly tarnished in six months."

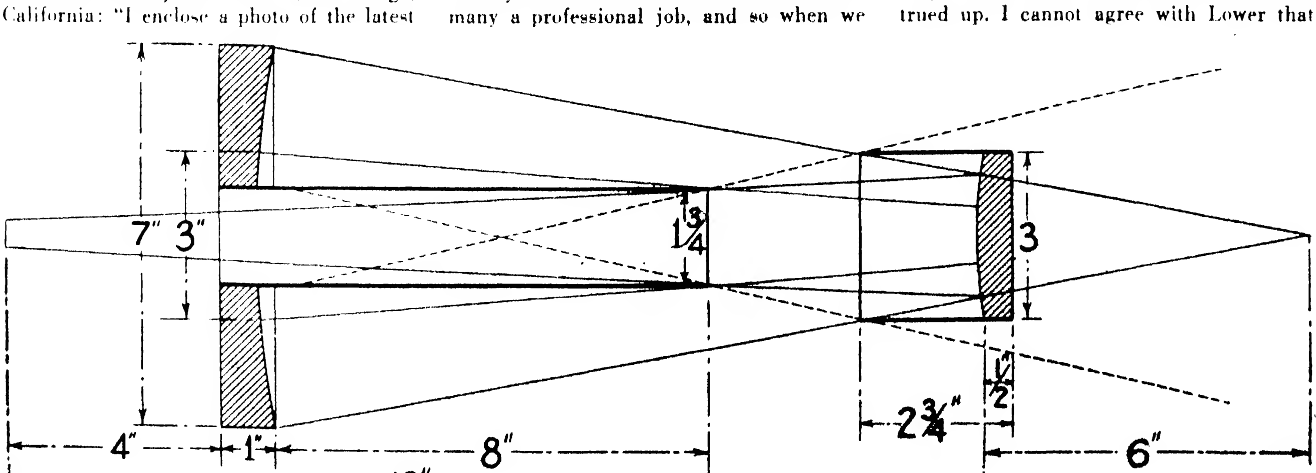
A COUPLE of years ago Lincoln K. Davis, 1351 Main Street, Brockton, Massachusetts, made one of the smoothest non-professional telescopes we have ever laid eyes on—in fact it was smoother than many a professional job, and so when we heard that he had more recently completed a vest-pocket Cassegrainian we asked him to describe it. Here is his letter:

"Your threat to run a photo of my Cass beside Lower's gives me cold feet, because I wrote you this was not a particularly smooth outfit. It was made to be readily portable, which it is, and it has been thrown around all summer, in the car and on a boat. While I can resolve Epsilon Lyrae plainly, there is too much scattered light in the field. At first I suspected a turned edge, but Everest pointed out what is probably the real reason—zonal irregularities. He said that he always smooths the surface

"Dad" Lower and Newt-Cass twins

of his mirrors with a very soft lap and short strokes, after figuring, with an invariable improvement.

"My primary is a good one, but the secondary was whacked into passable shape just about as my patience was running out, so this fall it will be overhauled and trued up. I cannot agree with Lower that



Layout of the Lower shielded Cassegrainian shown above, left hand column, and described in the text

the difficulty in figuring short focus mirrors has been overemphasized, as I had one devil of a time with mine.

"The photograph shows the telescope set up for terrestrial use with an erecting eyepiece, but minus the equatorial mount, which I carried away from a junk yard for a quarter (old movie camera tripod head, having a geared friction panoram motion,

The Davis portable Cassegrain

which makes a fine slow motion in right ascension).

"The primary is of Pyrex, 6" diameter, 13⅛" focus, giving a relative aperture of $f/2.2$. Primary has a 1½" hole through it. Secondary is of ⅜" plate, 2" diameter, 10½" radius of curvature, and is placed 9 13/16" in front of primary. Amplification is approximately 4×, so that overall focal length is about 52½", and effective aperture $f/9$. Box is of plywood, cloth covered, and is 7¼" square and 13" long. Weight of telescope proper is 7 pounds; the eyepiece and tripod shown add about 5 pounds to this.

"The mirrors were silvered by the dunking method, which is to say, face down. This eliminated all my previous troubles with pinholes, poor coats, and so on. The primary mirror is a fine one, if I do say so (ask Everest), and is within one percent of a parabola, but the secondary is fair only, with the result that the performance is not up to that of my 6" Newt, although in daytime use with a power of about 75× it works well.

"I spent 11 hours in grinding and polishing, and then 10 more figuring to a 60 percent correction, when I succeeded in knocking a big, flat chip out of the surface, and after a brief rest and cuss period, sadly went back to No. 60. In the meantime I built a machine, so the second attempt was made with this, and the total time ran into something like 45 hours, as the machine proved to be much slower than hand work. Final figuring was done by hand, and testing done by the Ronchi test and my modification of it. For obtaining parallel light I set up my Newt with a pinhole at infinity focus, and found this to work very well.

"For daytime use I made stops the size of the exit pupil for each eyepiece, and found this successfully cut out unwanted light, as Hindle says, so that the Cass gives as brilliant an image as the Newt in daylight.

"The hole in the primary was cut within an eighth of an inch of through before fine grinding, and then carried all the way

(Next page, please)

THE AMATEUR ASTRONOMER

(*Continued from preceding page*)

after figuring. This, on a drill press, was the easiest part of the whole job."

A TRIM Newt-Greg combination made by Dr. S. H. Sheib, a chemist and testing engineer, Box 737, Richmond, Virginia, is shown in the photograph below. Sheib says he had lots of fun making this telescope, but prefers his old Newtonians when it comes to actual use.

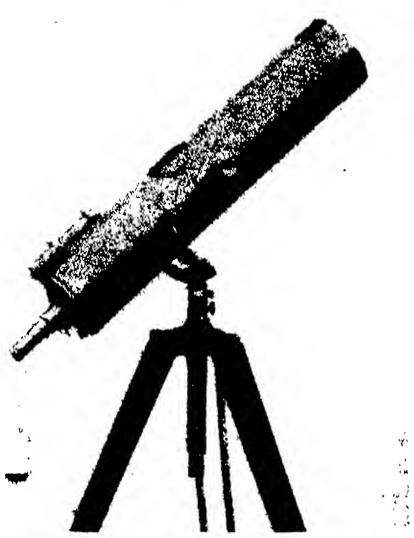
So, there you are: To make compound telescopes or not to - that is the question.

BY now the reader may have noticed that an extra page is given to this department. This addition, we hope, will be permanent, and is a reflection of the fact that the amateur telescope making hobby is still on the make.

TO continue, Mr. Davis mentioned above that he had a modification of the Ronchi test and we therefore asked him to tell the world about it. Here is what he says:

"I ran across the fact that the Ronchi may be conducted in broad daylight, or with any ordinary unshielded lamp. I placed a piece of ruled celluloid over a white card having a hole in it, to look through. Then I held the card at the center of curvature of the mirror under test, with the ruling facing the mirror, and a light source arranged to illuminate it rather brightly. By looking at the mirror through the hole in the card the Ronchi bands may be seen.

"As I figure it, light is reflected from the white card between the lines of the ruled screen, thus forming a multiplicity



Sheib's Newt-Greg combination

of slits or slit sources, and the returning rays are examined through the grating in the usual manner.

"I made another grating which works somewhat better by following Kirkham's suggestion ("A.T.M.," 266, Fig. 4) and threading a piece of brass having a hole in it, winding some fine wire around it, soldering the edges, and then cutting away the wires on one side. The wires facing the mirror were polished, with the side to face the eye blackened. In this case the polished wires act as very bright sources, with the added advantage that these sources and the point of observation are practically coincident, eliminating parallax effects, which with short focus mirrors are to be reckoned with."

There is some difference of opinion whether this method will give as good contrast as the single slit, also whether it will give periods of confusion ("A.T.M.," page 270, line 2). Try it and see what you think of it.

THE use of small or sub-diameter tools for amateurs is a heresy but amateurs, ever since this hobby took hold of them, have been dealing in heresies and the result has been an advance in the art of telescope making. So, avast with dogmas: Here is what two amateurs have written about small tools, at our suggestion. Believe it or not, a thing that works, works, even if it is all wrong. First, testimony from Harold A. Lower, who writes:

SPECIAL NOTICE TO AMATEUR TELESCOPE MAKERS: Be sure to see the supplementary item at the top of opposite page.—*The Editorial Staff*

"Ellison mentions that it is easy to grind and polish with small tools, but does not say how to do it. The 12-inch Pyrex mentioned above was rough ground face down for nine hours over a nine-inch tool. At the end of that time the curve had reached full depth at the center, as determined by measuring the sagitta, but lacked about an inch and a half of reaching the edge of the disk. (This first grinding face down leaves the edge of the mirror untouched—not even scratched.) When the curve had reached full depth in the center, the mirror was turned face up and the same tool used on top. One simply makes large epicycles all around the mirror, working mainly on the edge of the hollow, until the curve reaches the edge, at which time the curve should have become spherical. This grinding with the mirror face up also required nine hours, but did not deepen the center the slightest bit, so it is important to go to full depth in the first grinding while the mirror is face down.

"The fine grinding is all done with the mirror face up. The strokes used are large epicycles around the mirror, alternated with a zigzag stroke across the mirror. Do not permit the edge of the tool to overhang the edge of the mirror more than an inch or so, or a turned edge may result. One can tell when the surface is spherical, as the tool will slide freely in all directions. If it binds at any point, the surface is not spherical, and must be made so by working on the zone that binds until the tool will slide easily.

"Polishing was done with a 9-inch tool, with the mirror face up. The strokes used were large epicycles, alternated with the zigzag stroke. No difficulties with turned edge or zones were encountered, but it should be understood that good contact is just as important when using small tools as with full size. The handle of the small tool *must* be low and well centered. Never apply any pressure on the *edge* of the tool. Pressure may be applied to the center of the tool, and will merely hasten polishing.

"Figuring was done with a 6-inch tool, working with a variety of strokes, mainly over the center. The figure is easily controlled, as one simply applies more abrasion at the points that seem to need it. I would not recommend this small tool method for any except short focus mirrors. For $f/6$ or shorter, it works fine."

At the Pittsburgh meeting of the American Assn. for the Advancement of Science, Prof. Einstein made a special trip to see the exhibit of the amateur telescope makers and Leo J. Scanlon (left)

Paul Linde (see "A.T.M.," 138, 228) of Crossville, Tenn., submitted a 12-inch mirror to us for test and its figure proved up beautifully. On inquiring we found out he had figured it with small tools, so we asked him also to write a word about that method. This is what he says:

"The first time I tried a smaller-than-mirror tool was on a 12-inch of $f/4.5$. I used a 7-inch tool merely because it was one I happened to have. The facets were graduated to fine points at the outer edge. The strokes should be of about the same length and of an elliptical or circular nature while making one round around the pedestal, and should be changed with every round to prevent formation of zones. As a general rule the center of the tool should travel more often over that zone or diameter of the mirror which needs deepening most. Starting with short, circular strokes close to the edge of the mirror and keeping away from the center, the strokes should be lengthened with every other round until they are quite long, after which they can be gradually shortened.

"If there is a hill in the center it can easily be reduced by going with the tool across the mirror with slightly elliptical strokes, beginning with short ones and gradually increasing them with every second round. Turned up edge can be gotten rid of easily by pulling the tool farther over the edge of the mirror.

"Of course, there can be no fixed rules for using the small polisher and one simply has to experiment and test often to see the results. Any mistakes made by the small tool can be corrected in comparatively short time by the use of the full-sized tool to bring the figure back to flat. I find the small polisher method by far the easiest way to get all the zones right, especially with mirrors of short focal length. One word of warning: The mirror, when face up, is much more likely to be scratched."

The Mentor of Amateur Telescope Makers

Many readers have requested that a photograph of the conductor of The Amateur Astronomer department (see opposite page) be published, but the innate modesty of the gentleman has always stood in the way of granting these requests. Finally, the rest of the editorial staff connived to this end, and the above photo of "Doc" Ingalls is the result. By means of various dodges this has been kept from "Doc's" knowledge, and he will not see it until the magazine is published. Thus, if the newspapers, about the 15th of February, carry stories of wholesale mayhem on 40th Street, New York, you will know the reason

THE SCIENTIFIC AMERICAN DIGEST

(Continued from page 155)

its melting point of 235 degrees, Fahrenheit, almost up to its boiling point of 832 degrees. This high viscosity sulfur is carried by its suspending oil vehicle between the tool and the work in such a way that at temperatures and pressures at which the oil thins and ceases to act as a lubricant, the viscous molten sulfur supplies a high degree of true fluid film lubricant. The manufacturers claim that Sulflo is particularly efficacious for machining difficult metals such as chrome-vanadium steels, chrome nickel steels, Monel metal, and so on.—*A. E. B.*

Champagne or Bubbly Hard Cider?

PEOPLE with champagne thirsts had better watch the labels when buying their champagne, for deceptive bubbles have been found on the market in Washington and may be found elsewhere. This is on the authority of J. W. Sale, in charge of the Beverage Laboratory of the Food and Drug Administration, who found that bottles of a certain beverage from 13 retail places about the District had tricky labels, bubbles, impressive corks and wire ties, just what the consumer associates with champagne—and they contained nothing but bubbly hard cider.

The label on this bottle does not carry the word "champagne," the labels of genuine champagne seldom do; but it does carry the word "champyne." Three stores in the District carried the sign "Like Champagne." . . . One dealer gave a receipt for "champagne" when he had sold some of this "Champyne." Each bottle has on it a very small back label which carries the statement that the beverage is fermented apple juice, but this label is stuck on only at one end.

Beer Fattens Because . . . .

IF you are undernourished and feel that beer will build you up, medical science is prepared to recommend that you add the beverage to your usual diet. You can silence your critics by the scientifically attested statement that it is not only the alcohol in the beer that is building up your weight. The *Journal of the American Medical Association* says that only half of the calories in German beer are derived from alcohol; the rest come from "dextrin and protein-like extractives" in the beer. Here is food material "whose fattening properties may be very highly considered," according to one medical authority cited.—*Science Service.*

Preserving Paper Records with Cellophane

CELLOPHANE, of the acetate variety, provides a convenient and efficient means of preserving valuable written or printed records, says the United States Bureau of Standards, which has conducted experiments on this subject. The high degree of transparency, tensile strength, and smoothness of cellulose sheetings are attractive features for this use. The cellulose acetate sheeting appears to be particularly well adapted since it is apparently very stable if made from high-grade cellulose, can be secured in sheets only one thousandth of an inch thick, and is thermoplastic, that is, can be applied by combined heat and pressure.

The paper bearing the record is placed between two slightly larger sheets of the cellulose sheeting, and the combination is pressed between heated platens in a hydraulic press. This forms a smooth, firmly bound unit, with edges sealed by the overlapping edges of the cellulose sheeting. The last feature is important because it makes the combination quite impervious to air. —*A. E. B.*

Disease Defense a Normal Function

ONE of the most influential factors in the evolution of animals and man, probably one of the chief reasons we are alive today, is that our bodies have developed an ability to defend themselves against disease-producing bacteria. This capacity for defense is now considered a "normal and natural" physiological function comparable to digestion or respiration.

This defensive function the body applies not only to disease-producing bacteria, but to proteins and other normally harmless substances.

Medical knowledge in the past has regarded the phagocytes, or soldier cells in the blood and certain "antibodies" in the body fluids, as the forces which destroyed invading bacteria, and hence were alone responsible for immunity. The fixed tissues, such as the skin and muscle, were regarded as being hypersensitive. This meant that an individual might be both immune and hypersusceptible to the same germ at the same time.

According to Dr. Kahn's views, an immunized person, in accordance with the law of self preservation, is in a defensive state only. All the tissues of the body carry in common the burden of defense, whether fixed tissues, fluids, or phagocytes. In fact, the fixed tissues, such as skin and mucous membranes, carry a special load of defense because through the evolutionary ages they have been the first to come in contact with disease-producing bacteria.

DEADLIER

BACILLUS botulinus, long considered the most deadly poison, is actually less poisonous than a substance found during certain seasons in a sea mussel. However, the term "ptomaine poisoning" should never be applied to the effect of these substances.

Better Lubricating Oils

"VISCOSITY" is a chemist's word that has lately come out of the laboratory into public parlance. Roughly, the viscosity of a liquid is its consistency, or a measure of the ease with which it flows or pours. As everyone who reads the ads must know, the viscosity of the oil in an automobile engine is of prime importance to the oil's lubricating efficacy. Heretofore, the viscosity of the oil has depended pretty largely on the quality of petroleum from which the oil was extracted. Recently, however, chemists of the Standard Oil Development Company have discovered a substance that, when added in proper proportions to a lubricating oil, affects its viscosity to a remarkable extent without changing its other properties.

Exanol is the name given to this substance, although the name is understood to refer to a class of compounds rather than one specific material. Exanol is made from the "light ends" of refinery gasoline, by polymerization—a process by which the Exanol can be made in any form, from a light fluid oil to a thick, paraffin-like solid.

A large number of experiments and motor tests have been carried out to determine the operating characteristics of oils containing Exanol and the advantages gained in their use. They included ease of starting, consumption, pumping, and engine-sludging experiments. The results of this work have confirmed predictions based on the physical characteristics of Exanol blended oils, in that they have shown that these oils, in comparison with normal oils, give (1) lower consumption for comparable ease of starting; (2) lower carbon and sludge-forming tendencies; (3) excellent piston seal and lubrication.

This has led to commercial production of motor oils by this process. It is believed that Exanol will be a valuable tool for both the petroleum and the automotive industry, in that it provides a means of economically obtaining oils of better temperature-viscosity characteristics than can be manufactured solely by refining methods. Better low-temperature starting is obtained without loss of protection to other parts of the engine by excessive thinning out or loss of "body."—*A. E. B.*

A New "Winged Foot"

AN ice skate is merely a knife on which one skims over a slippery surface. Something new is a method of attaching this knife to the foot. The method employs a metallic slipper which fits the foot much as a dental plate fits the mouth.

A special cast of the foot is taken which gives a natural contour of the sole, surgi-

Mold from which "winged feet" are made, and two views of the skates

cally exact. This cast is marked for bearing center of the body weight; and for retention points of the foot. Both slipper and skate are fabricated from this basis. The metal used is a strong alloy of cobalt-chromium.

This new type of skate is the invention of Alan E. Murray, a professional skater, who describes the skate as follows:

"This skate is intended for use with a jacket which is a sort of leather stocking or Greek shoe which covers the metallic 'slipper' and laces down the front. However, with the Slipper Skate, skating of the most difficult sort may be accomplished with the slipper alone.

"All skating factors are improved in this skate: There is greater ice clearance; the weight is considerably lowered; the foot temperature is absolutely under control by means of the jacket. But the greatest virtue lies in the orthopedic principles which strengthen the foot. It is a positive corrective device. One feels better in street shoes after skating in it.

"The Mercury Slipper Skate will allow the ladies to have uppers to match each costume. Then for cold days there can be lamb's wool uppers. There can be different weight uppers for different activities. Thus one pair of skates provides the service of a number of outfits."

New Forest Films

THE service rendered mankind by the forest is discussed in a new one-reel talking picture, "The Forest Serves Man,"

recently released by the Division of Motion Pictures, United States Department of Agriculture, for the Forest Service.

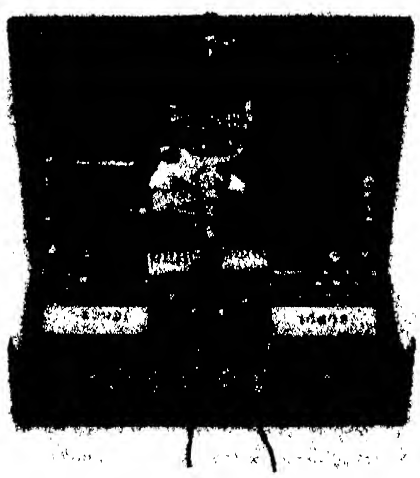
Scenes illustrating the importance of the forest to mankind in the production of timber, the prevention of erosion, and as a haven to both man and beast form the background for the lecture delivered by H. N. Wheeler of the Forest Service, who explains how proper treatment and care of the forest may insure its perpetuation.

Another new film (silent) sponsored by the Forest Service deals with the regulation of surplus deer in the Pisgah National Game Preserve to prevent destruction of future timber supply through over-grazing. Regulated Deer Hunting includes scenes showing fawns being reared by artificial means before transfer to understocked areas, older deer being trapped for transfer, and a sequence showing in detail a regulated deer hunt held for the removal of deer from congested areas.

Copies of these films can be obtained in both 16- and 35-millimeter size upon application to the Division of Motion Pictures, United States Department of Agriculture, Washington, D. C. No rental charge is made but the borrower must be responsible for transportation charges.

Personal Radio Phone

THE "personal radio-telephone," long envisioned by writers of pseudo-scientific fiction, is almost an accomplished fact. Intensive research on the ultra-short waves, in the vicinity of five meters, has brought about the development of combined receivers and transmitters, known as "transceivers," of exceedingly small dimensions.



Left: A five-meter transceiver in use. The long tubing is the antenna. *Above:* The interior of the unit, showing its extreme compactness

Typical of this progress is the compact Insuline five-meter transceiver which measures only 6¼ by 5 by 4 inches overall—hardly larger than a cigar box—and uses only two battery operated tubes which serve for both receiving and transmitting. With a four-foot length of brass or aluminum tubing acting as the antenna, this remarkable little outfit is capable of direct communication over distances as great as ten or fifteen miles. Even longer jumps have been made under good topographical conditions.

The required filament and plate batteries can be carried in coat pockets or in another small box tied to the transceiver itself. For automobile service the regular car storage battery is employed.

This transceiver is finding widespread use by radio amateurs and experimenters for many interesting field applications. It is available in kit form for easy assembly at home, the only tools required for the work being a screwdriver, a pair of pliers, and a soldering iron.

Oiticica

ONE of the activities of the National Paint, Varnish, and Lacquer Association has been to search the world for raw materials that can be used in varnish making. Dr. H. A. Gardner, of the Association, went to Brazil recently, and brought back reports of a natural oil which seems to hold great promise. If the oil is as tricky as its name, it ought to be good—the name is Oiticica.

Says Dr. Gardner, "The oiticica trees grow profusely in Brazil and produce in the fall a fruit in the form of a nut, containing a very large percentage of oil. Some of the trees produce two tons of fruit, an extraordinary quantity. The fruit contains about 60 percent of this oil which is very similar to china wood oil.

"The crude method of paint manufacture in Brazil has precluded its use there. Experiments with it have yielded poor results because of the fact that the crude or raw oil wrinkles very badly and forms a film. We have found, however, that if the oil is cooked with a resin, natural or synthetic, all wrinkle phenomena are overcome.

"This oil is a varnish oil that can be used to take the place of china wood or be used with china wood oil in the production of quick drying oil. The amount available in South America will be very large. This year's crop is probably the largest they have ever had. Production this year amounted to something like one hundred million barrels of oil."—*A. E. B.*

Powdered Skim Milk in Small Packages

POWDERED skim milk, a nutritious by-product of creameries, which in the past has been kept off the retail market because of the difficulty of marketing it in small quantities, is now available for distribution in small packages.

A new type of bag container for the

product has been tested by the Bureau of Dairy Industry of the Department of Agriculture and found suitable for general use. It keeps the powdered skim milk dry and eliminates the danger of spoilage.

Powdered skim milk has been used chiefly by ice-cream manufacturers, commercial bakers, and other large manufacturers of food products. Since it is a cheap means of obtaining many of the valuable nutrients in milk, the Department recommends its purchase by families trying to economize on their food budgets.

Food experts say that one pound of skim milk is equivalent in food value to 4¾ quarts of fresh skim milk. If the powdered skim milk is made available at food stores at 15 cents a pound, when mixed with water it would provide fluid skim milk at three cents or less a quart, according to the Department.

Almost everything which is contained in whole milk, except the fat, is contained in skim milk. It has calcium, phosphorus is high in protein and rich in vitamin G.

The Department nutritionists point out that dry skim milk has these same values and may be used in the same ways as fresh skim milk.

Nutritionists recommend that children be given dry skim milk in their cereals, milk soups, gravies, or in cocoa made with milk powder.

One warning is offered. The skim milk should be used to supplement the whole milk in the diet of children and not to take its place.

One way in which powdered skim milk can be used is in baking bread. Information on this use may be obtained by writing to the Bureau of Home Economics, Department of Agriculture.—*The United States News.*

WATT A METAL!

TO make one pound of aluminum requires about 3¾ pounds of ore, one pound of carbon, and 12,000 watt-hours of electricity. This is enough electricity to burn a 40-watt lamp continuously for more than 12 days.

An Old Hobby Revived

METEOROLOGY as a hobby for the people of the United States is in high favor with the Weather Bureau. Simple weather observations by 4500 co-operators, who receive no pay but use Government-owned instruments, have long added materially to the great mass of meteorological data on file in Washington. Additional records from dependable sources would be most useful in drawing a true picture of the climate of this continent.

Meteorology is a common hobby among private citizens abroad, Weather Bureau officials say. At one time it was a common hobby among American citizens also, but with the establishment of a professional forecasting service in 1870 interest in it waned, not to be revived until the last few years. The Weather Bureau ascribes this reawakened interest, in part at least, to the unusual weather features of recent times—the Mississippi flood of 1927, the abnormal winter weather over most of the country of 1933-34, and the drought of 1934; to advances in aviation, calling for more weather-wise pilots; and to the newly recognized relation between weather and forest fires, which has converted many foresters and lumbermen into lay students of meteorology.

In meteorology, Weather Bureau officials hold, people of many temperaments and different callings can find a satisfactory hobby. Merely keeping a diary of the weather will interest many, and such records have provided supplementary information of great value to official climatologists. Setting up meteorological instruments—simple sets as well as elaborate ones—and recording the readings will satisfy hobby seekers of a more scientific turn of mind. An intensive study of the clouds, accompanied by picture-taking, both still and moving, is suggested for others. Such photographs, the weather men say, may supply an important link in solving some weather mystery. Both statisticians and people concerned with human activities can take meteorology as a hobby, each group using a different angle of approach. Meteorological physics, air-mass analysis, and forecasting are among the many phases of meteorology that make worth-while hobbies, in the opinion of Weather Bureau officials.

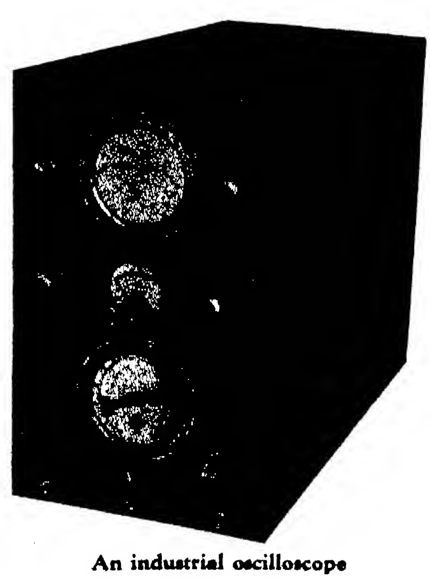
Oscilloscope for Industrial Applications

REMARKABLE strides have recently been made in the design of cathode-ray oscilloscopes with the result that the improved instruments may be conveniently used in the research laboratory, the industrial plant, or any place where the precise visual indication of electrical or mechanical functions is a necessity.

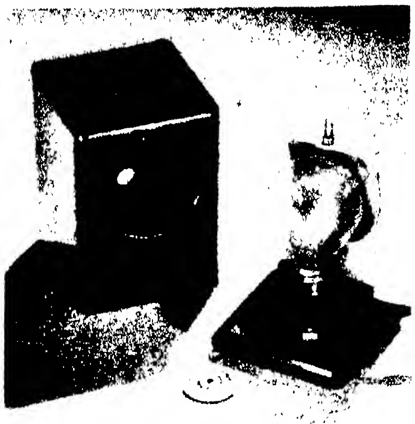
The advantages of the newly designed cathode-ray oscilloscopes for industrial applications are many. For example, the instrument illustrated is completely self-contained, is conveniently carried about and may be operated directly from any 110-120 volt alternating-current light line.

The pattern of the mechanical or electrical function under study appears directly on the screen of the tube at the upper part of the panel. Means are provided on the panel for adjusting the focus and controlling intensity.

The unit also contains an oscillator covering frequencies from 100 kilocycles to 22,000 kilocycles, the desired frequency



An industrial oscilloscope



The sub-stage lamp for microscope use, made by Spencer Lens Company, has been improved by the use of a molded Bakelite case. The housing is in two parts, one of them providing a base for the lamp socket

being selected by a dial on the front panel which may be read to an absolute value of 0.1 percent of the frequency desired. The device likewise contains a frequency-modulated oscillator and buffer amplifier which, used separately or in conjunction with the radio-frequency oscillator, permits the study of many electro-mechanical functions that would ordinarily require additional equipment to obtain a pattern. The sweep frequency is also provided by instruments included in the case.

The cathode-ray oscilloscope is gaining favor as a means of studying vibration in machinery, relative mechanical pressures, intermittent electrical functions, and so on. It has even been used for testing the muzzle velocity of projectiles.

Imports of Crime

THE major contribution to American crime, from the point of view of quantity of offenders, comes from those of foreign descent or foreign immigration. This has been shown heretofore by statistics, chiefly those compiled by Dr. H. H. Laughlin of the Carnegie Institution of Washington.

When it is figured out just how many of each nationality might be expected to appear in prison, on the basis of the numbers there are in the population, these "quotas" do not agree with the actual numbers present in the institutions. Some nationalities give more and others less than their quota to crime, just as some individuals give more than their quota to the community chest.

In general, the southern Europeans give more than those from the north of Europe. Those from the West Indies, Greece, Balkan States, and Asia have many more representatives in American prisons than the population justifies. Those from Switzerland, Ireland, and Germany have proportionally few representatives.

But lest those tracing descent from northern European families feel too superior, the other side of the picture is presented by the experience of the Department of Justice. The criminals who have lately been giving the most trouble—the "public enemy number one" class—have been almost exclusively of the northern European stock. They have been good Americans, with good old names easily pronounced, easily recognized as coming from the "best" part of Europe. There are Kelly, Nelson, Floyd, Dillinger, Hamilton, and many others.

And guilty or not guilty as he may be of murder, a man who has already cost the state a considerable sum because of his possession of "hot money" is from the proud stock of Germany—Bruno Richard Hauptmann. *Science Service.*

Low Water Alarm

AMONG new electrical devices recently introduced is one for controlling or indicating conductive liquid levels without recourse to floats. There are several distinct applications of the principle.

The two most common uses are: as a means for disconnecting the power supply to an oil burner or stoker in case of water failure in the boiler, and as a means for controlling pumps of all descriptions from sewage disposal to boiler feeders. Other uses include a low water alarm for domestic boilers, in which case the device serves directly as a buzzer or alarm bell, instead of as a relay.

The device depends for its action on the presence of an alternating magnetic flux generated by a small coil, consuming about the same energy as a door bell transformer. This flux has a choice of two magnetic paths, one thru an iron shunt integral with the laminated structure and another thru a relay armature of sufficient iron section.

A second or control coil is wound on the shunt. As long as the terminals of the control coil are open, the flux passes across the shunt, neglecting the armature path. If, however, this circuit be closed by means of electrodes in water, or other conductive agency, the current induced in the control coil sets up a reactive effect to the passage of flux across the shunt with the result that the flow of flux across the armature path is increased to a sufficient amount to actuate the armature. This armature movement is in turn utilized to open or close auxiliary circuits or by action with suitable vibrator contacts to sound an alarm.

Smooth Finish Lacquers

STUDIES into the fundamental character of lacquer films have apparently revealed facts that will eliminate the necessity of sanding a lacquered surface in order to obtain a high finish. The studies were undertaken by the Thomas and Hochwalt Laboratories of Dayton, Ohio, in behalf of the Sharpless Solvents Corporation, because somebody stopped to think that it is a rather foolish procedure to apply a lacquer, let it dry, and then laboriously sandpaper off 20 or 30 percent of the coating in order to get a smooth surface.

Two fundamental discoveries were made in the course of this investigation: First, that the presence of even minute quantities of water in the lacquer film was responsible for the roughness of surface that made sanding necessary; second, that the presence of medium- or low-boiling solvents in the lacquer is definitely conducive to a rough surface. Water finds its way into lacquer formulas in devious ways. Some creeps in with the nitro-cellulose that is the basis of lacquer; some is carried in by the

solvents, plasticizers, and thinners which although supposedly free from water, often absorb it from the atmosphere; frequently, moisture gets into the lacquer by way of the compressed air line and, finally, moisture may be absorbed from the air after the lacquer has been applied.

By very carefully drying the nitro-cellulose used in lacquer manufacture, the resultant film shows practically no tendency to blister or peel and requires no sanding. The drying of the nitro-cellulose is accomplished by washing it in alcohol. By especially careful procedure, the other sources of water contamination may be eliminated. —*A. E. B.*

ANCIENT EGG

AN age of 225,000,000 years is estimated for a fossil egg recently discovered in north central Texas. Three inches long and rusty in coloring, it is more than twice the age of the Gobi Desert eggs found several years ago. The monster which laid it has not been identified.

Examining the ancient egg described in paragraph at the immediate left

Better All-Wave Radio Reception

A FURTHER refinement in noiseless antenna systems for all-wave reception is offered in the variable impedance matching of downlead to receiver. For the first time this feature is made possible by a simple accessory applicable to any doublet antenna and receiver. The knob adjustment brings about precision balance between antenna system and receiver for greatest sensitivity and loudest signals, while reducing still further any remaining noises.

Known as the TACO Noise Rejector, the variable impedance matching unit is a development of Technical Appliance Corporation. Compact and handy, the unit is mounted alongside antenna and ground binding posts of the receiver by means of base lugs. Two short leads connect with receiver. Two screw terminals take the twisted-pair downlead cable of the usual doublet antenna. With the set in operation, the noise rejector knob is adjusted for maximum transfer of signal energy from downlead to set, as well as for minimum background noise. An intricate coupling coil with a plurality of parallel windings, in combination with a variable component, following a carefully worked out engineering formula, forms the basis of this aid to modern reception.

Mind, Brain, and Survival

DR. WILLIAM BROWN, lecturing on "Modern Science and the Possibility of Survival," at the Survival League, discussed the various theories of relation of mind to brain, and expressed the view that nothing firmly established in modern science makes personal survival after bodily death intellectually inconceivable. But the task of obtaining reliable evidence is beset with enormous difficulties. The results and messages in mediumistic trance should be closely scrutinized in the light of modern knowledge of the psychology of the unconscious, and sifted with due regard to the statistical laws of chance coincidence. Spontaneous psychic experiences on the part of private individuals, though more reliable in other respects, are specially difficult to assess statistically. There is little doubt that a large proportion of the apparent evidence for survival has to be rejected by strict science; but when all the sifting has been done there remains a small residuum very difficult to explain. Phenomena can only be fitted into a scientific system if their conditions of causation are known, and this is far from being the case with psychic phenomena, although some of the more general conditions are being gradually revealed. Very thoroughgoing psychological analysis of selected mediums will advance our knowledge considerably in this dim borderland of science, and may indicate further lines of investigation.—*Nature* (London).

Chemical Safety

CHEMICAL manufacturers must be constantly on guard against possible harmful effects on employees of materials handled. The DuPont company is erecting a medical research laboratory to cost 100,000 dollars, the purpose of which is to study the possible effect of the company's new chemical products upon the health of employees during steps of manufacture and to study all possible effects of the new products on public health before the products are marketed.—*A. E. B.*

Artificial Lightning More Powerful Than Nature's

MAN-MADE lightning rivaling nature's own thunderbolts, with electrical current of 250,000 amperes, was put on display in Pittsfield, Massachusetts, recently in a crashing, flaming exhibition by engineers of the General Electric Company's high-voltage laboratory.

Measurements of current surges in power lines have indicated that a direct hit by a natural stroke of lightning causes the current to mount to only 150,000 amperes. The current in the demonstration was discharged at 150,000 volts potential.

The electrical power expended during the eight one-millionths of a second of the flashing "bolt" was 30,000,000,000 watts.

This is 30 times the electrical power developed by the hydro-electric plants at Niagara Falls and as much as the combined electrical output of all the electrical plants in the United States.

Ordinary copper wires for handling heavy currents were blown apart and vaporized in a few millionths of a second during the demonstration. A section of reenforced concrete was shattered by the impact of the artificial lightning bolt just as a concrete structure is sometimes wrecked by natural lightning.

A metallic conductor large enough to carry the tremendous current without fusing is subjected to powerful mechanical forces during its transmission of the current. A flat strip of copper shows the "pinch effect" which changes it from a ribbon to a nearly round cross section.

The new high-current apparatus is a companion instrument for the 10,000,000-volt artificial lightning generator already in use at General Electric's high-voltage laboratory. Both instruments are used in the research which the company is, and has been, making to study the effect of natural lightning on long distance transmission lines.

Already many protectives have been devised to improve the service to distant places which formerly was interrupted by lightning strikes.—Copyright, *Science Service*.

Home Battery Charger

THE use of larger and higher compression engines, dual electric horns, more powerful lights, auto radios and the like, has imposed such a drain upon car batteries that some car owners find it necessary to recharge the battery quite often. The rate of recharging by operation of the car is too slow to keep the battery fully charged.

To meet this need, the Automatic Electrical Devices Company has developed a new "Homcharger" which they claim will charge the automobile battery overnight for a nickel. They claim that this new equipment will charge a battery faster and cheaper than chargers now commonly used.

The Hi-Rate Homcharger is for use only on alternating current, 115 volts, 60 cycles, for charging a three cell storage battery at 10 amperes at the beginning and tapering off to six amperes at the finish. Connection is made to the battery through a clamp-on receptacle which requires no tools and needs but a single connection to the ammeter terminal in the rear of the dash.

First Aid for the overworked automobile battery, in the shape of a high-rate charger for use at home

35-Ton Propellers Revolve at the Touch of a Finger

SO perfectly balanced are the huge propellers of the Cunard White Star superliner, *Queen Mary*, now being "fitted out" in Scotland, that even the touch of a finger on the giant blades is enough to set them in motion.

Each of the four propellers weighs 35 tons, being the largest manganese bronze units ever cast. The total weight of each casting in the rough state was about 55 tons, of which 48 tons was in the main pour, from two ladles, the balance being added as feeding metal at intervals, over a period of 4½ hours, to make good the liquid shrinkage and to ensure soundness in the propeller itself.

This mass of propeller metal required 14 days to cool down to a temperature at which the casting could be safely removed from the mold. The construction and assembly of the molds called for the highest degree of accuracy by the skilled craftsmen employed on this work, and eight weeks were required for preparing and drying each mold. The melting, casting, and handling also required infinite foresight, and care, after which the propellers were machined, dressed, polished, and statically balanced.

Vitamin D A Dental Aid

THAT vitamin D helps to protect teeth from decay is borne out by studies recently completed by Dr. E. C. McBeath, of Columbia University. Child-feeding experiments were carried on for six months, and it was found that the carious surfaces of the teeth of the children on a regular diet had increased from 55 to 84 percent, while those who had taken 300 units of vitamin D daily had an increase of 10 to 18 percent.—*A. E. B.*

Vegetable Vitamin D

USING a highly refined vegetable oil as a base, and dissolving in it a pro-vitamin from a vegetable source, Lancaster, Inc., produces "Astra-D," a vitamin-D concentrate. The pro-vitamin used is highly activated by natural solar irradiation. The manufacturer reports that this concentrate is being used in bakery products, mayonnaise, cottage cheese, salad dressing, peanut butter, candy, macaroni products, jams, and jellies.—*A. E. B.*

Insect Racketeering

PARASITIC ants of a new species, recently discovered in southern Germany by Dr. Karl Gösswald of the Institute for Applied Zoology, Munich, set a new record for insect racketeering. If Solomon could have seen these insects, he might have hesitated about making a blanket commendation of ants in general as models of industry and thrift.

This ant's career of wickedness begins when a fertile queen intrudes herself into the nest of another species of ant—the normal, hardworking kind that inspired

Solomon's praise. Ordinarily the workers in the nest would make short work of any stranger, but she somehow manages to flatter herself into their good graces.

Proceeding thus unmolested to the chamber of the rightful queen, the intruder springs upon her back and fastens her strong jaws into the body of the much larger insect. The home queen does nothing to defend herself, and the workers still pay no attention.

After the rightful queen is dead, the invading queen is accepted by the duped workers as their own. She proceeds to lay eggs of her own parasitic species, which are cared for by the workers.

These eggs produce "neuters" or undeveloped females, which in a normal ant species constitute the worker caste. But in this parasitic species they are as useless as their mother, living lives of complete idleness, accepting the food the active workers bring them and giving no thanks for it—as typical a lot of alien aristocrats as ever afflicted a community, whether ant or human.

It might be expected that when the last of the workers had died off, the helpless parasites would perish. But here the nature of the "host" ant workers intervenes to play a mean trick on them and perpetuate their slavery.

Normally, when an ant colony loses its queen, some of the usually "sexless" workers lay unfertilized eggs, just as worker bees do under similar circumstances. These eggs develop only male or drone insects, useless as workers. But with these poor afflicted ants, the eggs laid by the workers produce new workers, so that the "aristocratic" idle parasites always have a full population of exploitable "proletariat" workers to take care of them.—*Science Service.*

CURRENT BULLETIN BRIEFS

HYDRO-ELECTRIC PROGRESS IN CANADA DURING 1934. Bulletin No. 1784. An annual review of hydro-electric and water-power development during 1934 which gives a brief description of those undertakings which were begun or which reached the developed stage during the period. *Director of the Dominion Water Power and Hydrometric Bureau, Ottawa, Canada.—Gratis.*

BETTER TENANT FARMING, by Cornelius J. Claassen, is written for all farm owners, especially those who lease their farms to tenants. Many helpful suggestions are offered as to how you can improve your land and increase your profits without incurring great expenditures. *Farmers National Company, Omaha, Nebraska.—Gratis.*

GENERAL SHORT-WAVE AND PUBLIC ADDRESS MANUAL, by Sydney Bass and Herman Cosman, is a series of articles on the construction of radio equipment, supplemented by valuable charts and tables. *Bulletin 335B, Scientific American, 24 West 40th Street, New York City.—50 cents postpaid.*

THE THIRTY-HOUR WEEK, by H. G. Moulton and Maurice Leven. A 20-page essay weighing carefully the advisability of a 30-hour work week. Such questions as "How would the 30-hour week affect wealth production?", "Is a shortened working week a satisfactory means of relief?", and "Would the 30-hour week generate recovery?", are discussed and answered and a startling conclusion is drawn. *The Brookings Institution, Washington, D. C.—Gratis.*

NOVEL SHORT WAVE DIAL LOG. With a single setting of the rotating arm, the days of the week, hours of broadcasting, call letters, kilocycles, city, and country in which station is located, all appear in a straight line and can be read at a glance. *Bulletin 335A, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

WATER AS AN ENGINEERING AND INDUSTRIAL MATERIAL concerns itself with industrial applications, power plants, water analysis, and detection of impurities. Comprising 45 pages with illustrations, it treats of the removal of suspended solids from water, detrimental effect and removal of manganese, and the effect of color on industrial water supplies. *American Society for Testing Materials, 260 South Broad St., Philadelphia, Pennsylvania.—50c.*

ELECTRICAL CAPACITORS is a remarkable little booklet telling the story of the construction of condensers for various electrical purposes. An unusual series of photographs presented in a modernistic manner carries the reader from raw material to finished units. *Bulletin 335C, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

SIXTY WAYS TO PREPARE CHEAPER CUTS OF MEAT. Of interest to those who must stretch their "meat dollars" is the new circular of 60 tested recipes for meat dishes at low cost. Ten years of research by the Bureau of Home Economics has brought to light much material about the science of meat cookery, all of which is contained in the circular. *Superintendent of Documents, Government Printing Office, Washington, D. C.—5c.*

PEAK EFFICIENCY DESIGN ON THE SHORT WAVES, by James Millen, M. E., describes the engineering of a universal AC-DC receiver especially designed for amateur band reception. Circuit diagrams and data are given. *Bulletin 335D, Scientific American, 24 West 40th Street, New York City.—10 cents.*

STATISTICS OF WATERWAYS. Based upon official reports and records available up to December 1, 1934, this bulletin is designed as a convenient reference for statistics of waterways and waterway operations in the United States. *Bureau of Railway Economics of the Association of American Railroads, Washington, D. C.—Gratis.*

WORLD-WIDE SHORT-WAVE RECEPTION, by James Millen, M. E., tells in particular of interesting experimental work to be found in the short-wave bands. Receivers and antenna systems are described and illustrated. *Bulletin 335E, Scientific American, 24 West 40th Street, New York City.—10 cents.*

Books SELECTED BY THE EDITORS

(*Continued from page* 115)
biger's hypothesis" and the publishers assert that many astronomers have adopted it, a statement concerning which this reviewer is from the well-known state of Missouri. For readers who prefer their science wild this book is recommended—with the warning that they may accept its contents as science only at their own risk.—$3.15 postpaid.—*A. G. I.*

THE STARS FOR CHILDREN

By Gaylord Johnson

THIS book is a "sugar-coated pill" by means of which youngsters may be encouraged to learn a lot about astronomy without realizing it. The text is in story form but from end to end it is packed with solid facts. The illustrations are copious and attractive, as well as ingenious. Before passing this book to that boy or girl of 10 to 14, you will no doubt secretly read it yourself, and will pick up more practical elementary astronomy from it than you could learn from a textbook. We did.—$1.65 postpaid.—*A. G. I.*

THE POETRY OF MATHEMATICS, AND OTHER ESSAYS

By David Eugene Smith, Professor of Mathematics, Columbia University

THIS little book contains five essays which will interest those who are in love with mathematics, yet they are not themselves mathematical. Besides the essay which gives the book its title, the others are: The Call of Mathematics; Religio Mathematici; Thomas Jefferson and Mathematics; Gaspard Monge, Politician. On reading the one entitled Religio Mathematici, the reason why mathematical enthusiasts are mathematical enthusiasts will appear: mathematics is a religion and its pursuit is a worship, and at long last we understand the hold it has on its disciples. A readable little book. — 85 cents postpaid.—*A. G. I.*

APPLIED ACOUSTICS

By Harry F. Olson, E.E., Ph.D. and Frank Massa, B.S., M.Sc.

RADIO broadcasting and sound motion pictures have resulted in a vast increase in knowledge in the science of acoustics. Fundamental principles of acoustics have been known and understood for years, but the applications of these principles to broadcasting and motion pictures have necessitated a vast amount of research work in order to couple theory and practice satisfactorily. The present book is an excellent attempt to gather all of the data which have been built up in the last few years and to present them in a form which makes possible ready reference. Since much of the science of acoustics depends upon mathematics, this text can be followed intelligently only by those who have the required background.—$4.70 postpaid. *A. P. P.*

HOW TO IDENTIFY THE STARS

By Willis I. Milham, Ph.D.

THIS little book gives practical instructions for learning the constellations. The method is the same as that used in the course in descriptive astronomy at Williams College, where the author is professor of astronomy. It contains 24 black charts of the principal constellations.—$1.65 postpaid.

—*A. G. I.*

HEREDITY AND DISEASE

By Otto L. Mohr, M. D.

THIS is an elementary presentation of what science knows today about the actual physical or physiological mechanism of inheritance, the genes of the heredity cells. This new science is not based on elusive guesswork or psychology but on actual, tangible, observable cells studied under the microscope. In this book we learn the definite principles of inheritance—genetics, in other words. A final chapter takes up the bearing of the new genetic science on human affairs, such as intermarriage, heredity and disease, and human breeding. Genetics is fast becoming one of the exact sciences.—$3.70 postpaid.—*A. G. I.*

GENERAL ASTRONOMY

By H. Spencer Jones, Sc.D., F.R.S.

THIS is the second edition of a standard astronomy which appeared in 1922 but it has been almost entirely rewritten. The author is the Astronomer Royal at Greenwich. The many amateur astronomers who are known to be "collecting textbooks" in order to have the last word on this and that at their fingertips will do well to obtain this one. It has 426 pages and many illustrations, and is almost wholly non-mathematical.—$3.95 postpaid.—*A. G. I.*

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

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The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN, April, 1935. Vol. No. 152, No 4, entered at the New York, N. Y. Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

ACROSS THE EDITOR'S DESK

A QUESTION which often leads to interesting arguments is that of the position occupied by American aviation in relationship to the rest of the world. We have been unusually fortunate in obtaining from Igor Sikorsky, well known aircraft designer, an article giving his impressions of the present status of aviation in Europe as compared with the United States. "The main conclusion to be drawn from an air tour of Europe," says Mr. Sikorsky, in his article scheduled for publication next month, "is that American aviation is definitely superior to European aviation, although it is faced with a real danger of rapidly losing its lead." Mr. Sikorsky recently flew over several thousand miles of Europe and visited the most important aeronautical centers. Thus he is able to present in a lucid manner the impressions registered upon his trained mind of the things which he saw.

AMATEUR microscopists will revel in the first part of a two-part article to be published in our next issue. In describing a home-built polarizer, Philip R. Tarr says: "Of the innumerable thrilling and educational observations that may be made with an ordinary microscope, few can compare either in beauty or fascination to those made with polarized light. An unlimited field may be opened by adding the necessary polarizing equipment to your own microscope." Both parts of the article will be well illustrated with photographs and drawings by the author.

THE first of three articles on railroading, promised in these columns last month, starts on page 180 of this issue. Here you may read of the advantages and disadvantages of steam power, the old standby of railroading since its inception. Next month's article will deal with electrification. Writing on this phase of the subject Mr. G. I. Wright, Chief Electrical Engineer of the Reading Company and the Central Rail Road of New Jersey, says: "Railroad transportation is undergoing a rapid change. Many think we are on the threshold of a new era in which basic alterations in methods and equipment will be adopted. Where does electric traction fit into this picture and what has it accomplished? What are its advantages in relationship to the future?" Mr. Wright proceeds to answer these questions and to give the reader a broad insight into one of the much discussed phases of transportation. The third article, on Diesel-electric power, will appear in May.

NEXT MONTH

¶ Igor Sikorsky gives his impressions of the aeronautical industry in Europe.

¶ "Real Thrills From a Home-Built Polarizer," by Philip R. Tarr.

¶ Railroad electrification: Its place in transportation, by G. I. Wright.

¶ "Did Man Exist in the Miocene Epoch?" by J. Reid Moir.

¶ "Candid" and theater photography, by Jacob Deschin.

¶ Die casting in industry, by Philip H. Smith.

IT is always of intense interest to speculate about the age of man on the face of his little home planet. Gradually this estimated age has been extended backward in prehistoric time. In an article to be published soon, J. Reid Moir shows that, if recent evidence proves valid, man's antiquity will be extended to about 3,000,000 years. The evidence in question consists of flint instruments unearthed in certain deposits in England. These implements are being carefully studied by competent authorities and perhaps it may soon be possible to say definitely when man first made his appearance on this planet. The trail of ancient man is leading us into strange regions but its beginning still remains hidden in the mists of antiquity.

INTENSIVE research recently applied to die casting in industry has so changed practice that today there are uses for die castings that were undreamed of five years ago. Stampings and sand castings are, in many cases, being replaced by die castings, and better products are often being made at lower cost. Just what has been achieved in this field, and what discoveries have made these achievements possible, will be told in an article next month by Philip H. Smith.

SO popular among our readers was the article on miniature cameras published in our February number that we have scheduled for next month an article on "candid" and theater photography, both of which are mainly restricted to the use of the small cameras. Jacob Deschin, the author of this article, says: "The superiority of the miniature camera for this type of work is obvious; its compactness, ready accessibility, ease of concealment just before and during exposure are advantages so patent that no one would think of debating the subject." There are certain tricks which the successful candid photographer must master, some of them pertaining to the photographer himself and some to his equipment. Mr. Deschin points these out and has also supplied a series of excellent photographs which will be used to illustrate the text.

Orson D. Munn
Editor and Publisher

Books SELECTED BY THE EDITORS

MEN, MIRRORS AND STARS

By G. Edward Pendray

EVERY amateur astronomer, every amateur telescope maker, and everyone who takes any interest in astronomy, should possess a copy of this book. In addition, everybody else should possess it. No similar book has ever been written, yet the content of it has been available to writers for a long time. It contains many facts about people and observatories and the telescopes and other instruments in them—tradition, shop talk, even gossip—that have previously existed only in oral form. Its reader will absorb as much general background about the astronomical world as would require five years by the usual piecemeal process.

The book has three sections. Section I is on the history of the evolution of the telescope. Section II is on telescope principles—elementary, of course, for this is a popular, not a technical, book. Section III is on early and modern American telescopes, famous American telescope makers, including amateurs, and future telescopes. The chapter entitled "Amateur Telescope Makers and How They Have Advanced the Art" should boom the market for hat stretchers among all normally constituted amateurs. The appendices contain much special data on American observatories.

This is a book which can be read, not merely by the scientifically inclined member of the family, but *will* be read and easily followed by the rest, and it will tell them what the great modern boom in astronomical interest is all about. It is an all-around, many-sided book, written in a bright, refreshing style, by the science editor of *The Literary Digest*.—$3.14 postpaid.—*A. G. I.*

JANE'S FIGHTING SHIPS FOR 1934

Dr. Oscar Parkes, Editor

JANE'S ALL THE WORLD'S AIRCRAFT 1934

C. G. Grey, Editor

TO take care of the many constructional details and advancements that have been made in a year of more than usual activity both in naval and aircraft construction, these two standard works have been expanded and much detailed information added. Silhouettes and descriptions of new war ships are included in "Jane's Fighting Ships," together with discussion regarding the possibility of further building in view of the breakdown of plans for a further naval limitation agreement. "Jane's All the World's Aircraft" includes discussions of the newer fighting aircraft as well as of the several huge commercial planes which have been built during the year.—"Jane's Fighting Ships" is $23.00 plus duty; "Jane's All the World's Aircraft" is $23.00 plus duty.—*F. D. M.*

BRASSEY'S NAVAL & SHIPPING ANNUAL—1935

Edited by Commander Charles N. Robinson, R.N., and H. M. Ross

IT is a pleasure each year to study this valuable collection of material —now in its 46th year of publication—for in *no* other compilation of naval and shipping notes, data, and discussions can such a wealth of information be found. Particularly interesting to Americans are the authoritative articles on "Naval Forces of the British Empire," "Foreign Navies," "Relative Naval Strength," "Disarmament and Naval Policy," and "Japan and her Navy." "The Merchant Shipping Section," of eight chapters, and the "Air Section," of three chapters, give much valuable data as do also the 160-odd pages of references. Profiles and plans are especially illuminating.—$13.00 postpaid.—*F. D. M.*

TESTING PRECIOUS METALS

By C. M. Hoke

IS it 18K or 14K? Is it gold at all? Is it silver, platinum, or palladium? A revised edition of a valuable book for all who buy, sell, work, or admire the precious metals. It tells how to figure the value of old gold, dentures, solutions, and how to handle them to advantage.—$1.00 postpaid.—*F. D. M.*

IN THE SEALED CAVE

By Louis Herrman

A MODERN addition to the well-known Gulliver's Travels. The present author has taken up the work of Dean Swift and has written, upon a modern basis, a further adventure of Capt. Lemuel Gulliver. The basis upon which this story is built is an admirable approach to so-called scientific fiction, although the present reviewer cannot say as much for the development of the theme. It does, however, make a readable story and will teach the reader a certain amount of sugar-coated anthropology. In the story Gulliver discovers, in 1721, a group of Mousterian people who have lived for thousands of years in a cave on a small island in the Aegean Sea. His adventures among these people and the reason why he was forced to leave them make a story not unworthy of comparison with some of Gulliver's earlier travels.—$2.15 postpaid.—*A. P. P.*

YOUR CARRIAGE, MADAM

By Janet Lane

WHILE this little book of 130 pages is dedicated to the purpose of developing feminine grace and charm through its instruction in good posture, to our minds a more important result

(Please turn to page 223)

Personalities in Science

REV. FATHER JULIUS A. NIEUWLAND

THE much-prized gold medal of the American Institute, one of the oldest awards in the United States, has been presented to the Rev. Father Julius A. Nieuwland of Notre Dame University, for the discovery of a process of making synthetic rubber. The American Institute of the City of New York was organized 107 years ago and a list of the recipients of its medal reads like a blue book of progress in the arts, sciences, and industry.

Dr. Nieuwland, in addition to being a professor of organic chemistry, is also a botanist, and a priest of the Roman Catholic Church. He started in 1904 to solve the chemical riddles involved in making artificial rubber, and today it is being introduced as a factory-made product.

Many efforts have been made since 1860 to produce an artificial rubber. In the earliest experiments materials were used that were obtained from the chemical breaking down of the natural rubber. Later, intermediate products such as isoprene were used, and also similar chemical compounds. When alterations in their molecular arrangements were made they changed into resilient, elastic substances, but these products were inferior to natural rubber. The accomplishments had scientific value, but they had little commercial value, as the starting products, isoprene and butadiene, were much more expensive than natural rubber.

The Rev. Father Nieuwland started his process with a much simpler and cheaper substance—acetylene. This was changed by water to acetaldehyde and oxidized to acetic acid, converted to acetone and reduced to pinacol. The line of research that led to eventual success started when the acetylene was passed through metal chlorides and a gas was produced that could not be isolated. In later experiments with ammonium chloride, both the gas and an oil were obtained. The oil proved to be divinyl acetylene and to have chemical properties that were superior to any previously used compounds for rubber making. Addition of sulfur dichloride produced a rubber, but it was too plastic for practical use.

The E. I. duPont de Nemours Company became interested in the work and arrangements were made under which they took over the commercial development. Their laboratories produced the gas which Father Nieuwland had been unable to isolate in 1906, and found it was monovinyl acetylene which could be changed easily to chlorobutadiene. This differed but slightly from isoprene, the parent substance of natural rubber. When this substance was allowed to stand a few days it changed to a stiff jelly, which, on heating, changed to rubber. This rubber was found to be superior in many ways to the natural product.

"While artificial rubber cannot be made as cheaply, at present, as natural rubber can be produced, the synthetic rubber products of the Duprene type serve as a valuable check to control the price," says *Science Service*. "During wartime and by means of special cartels, rubber has often sold as high as $1.25 a pound. Now it is said that the cartels dare not raise the price of natural rubber above 20 cents a pound. Based on America's annual consumption of rubber, it is estimated that 375 million dollars a year is saved due to the difference in the present price of rubber and what it might be if there was no artificial competitor at hand to serve as a check against price-rising."

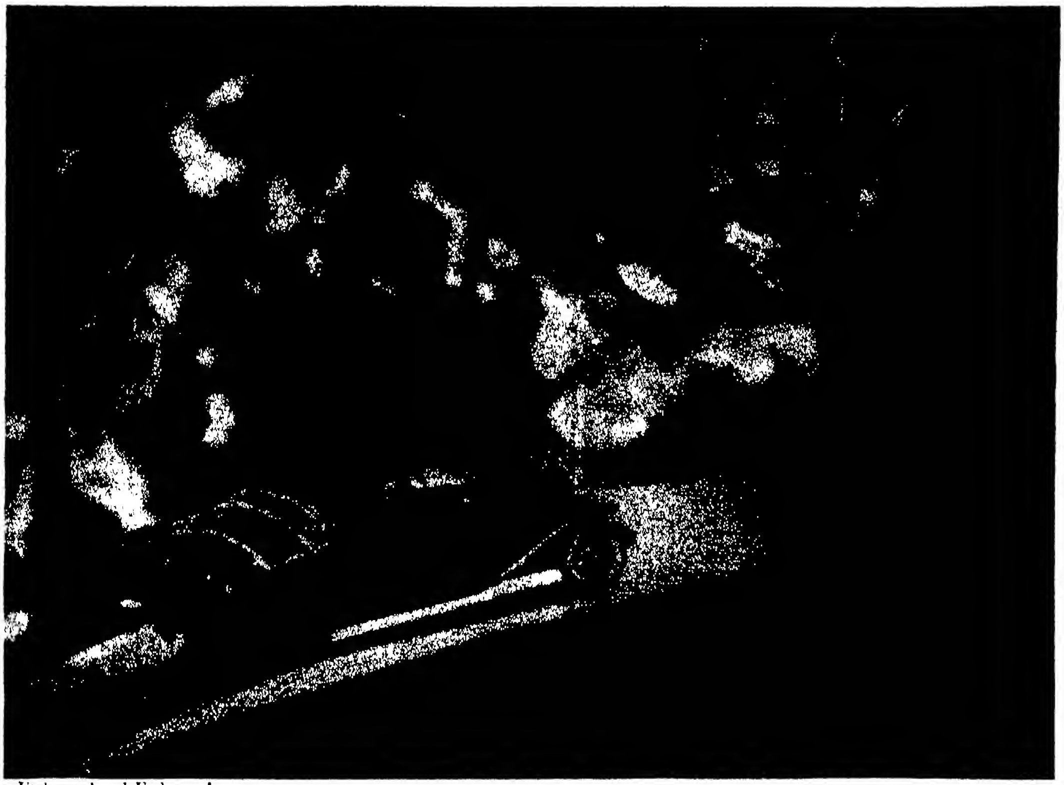
The Rev. Father Nieuwland was born in Hansbeke, Belgium, in 1878, but grew up in the United States. He graduated from Notre Dame University and continued his studies at the Catholic University, where he received his Ph.D. in 1904. In the same year he was ordained a priest and became a member of the Notre Dame faculty as Professor of Organic Chemistry.

The photograph shown above was taken in Father Nieuwland's laboratory especially for SCIENTIFIC AMERICAN.

Photography on Two Selected Wavelengths

Why Photographs Taken on Long Wavelengths Do Not Look Like Those Which Are Taken With the Waves With Which the Eye is Familiar: Because of Scattering and Differing Reflectances

THE two photographs on this page show the same subject, a 12-inch reflecting telescope made, as were the photographs, by James S. Fasseno, of Pasadena, California. The upper picture was made with rays having an average wavelength of about 1/50,000 inch, while the lower one was "received" by the camera on wavelengths about 50 percent longer—waves which the eye does not perceive because they are in the infra-red. In the infra-red photograph—the lower one—the sky photographs light on the negative hence dark on the print, because very few of the longer waves with which it was taken are scattered by the molecules of the air, and therefore they do not come from the sky, but come to the object from the sun alone. But these same molecules do scatter the shorter waves which are "visible" to the ordinary plate and to the eye, particularly those in the blue, and this is why the sky is blue and why the negative of the ordinary plate is darkened. On the other hand, all foliage contains a substance called chlorophyll, which reflects not only the green rays, which we can see, but very strongly reflects the longer infra-red rays. These are the reasons why infra-red photographs look like snow scenes at night.



Underwood and Underwood

A striking example of advertising photography described in the text. Three negatives were made for the car, head, and hand, and combined in a fourth when the "smoke" was added

PHOTOGRAPHY IN THE 'ADS'

Behind the Scenes . . . Artists of the Camera . . . Temperamental Food Models . . . Photographic Murals . . . Photomontage . . . Color Photography

By JACOB DESCHIN

BORROWING a trick or two from the movies and adding a few of their own, modern commercial photographers are daily turning out pictorial miracles undreamed of only a few years ago. Advertising illustrations which often cause a gasp of astonishment bring these magicians of the sensitized celluloid and glass as much as 500 to 1000 dollars for a single picture. High prices? Yes, on the face of it. But, as Preston Duncan, Hollywood photographer, says: "Almost every person forgets the hundred-and-one real ramifications of the photographer's problem. An artist with pen or brush can usually create at his own easel, but the photographer, of whom realism is demanded, must seek and find or build or trick—all of which requires much preparation, time, skill, equipment, organization."

A successful commercial photographer must know a good deal more than how to arrange his subject properly, push the button, and print a picture. He must not only be master of the technical features of his profession, but a jack-of-all-trades besides, in addition to being imaginative and resourceful, inventive and mechanically versatile. He must not only be able to reproduce a subject to the very best advantage but, according to Ansel Adams, San Francisco photographer, build up the product so that "the softness of velvet appears even richer and deeper than it actually is, steel becomes even harder, and a ten-floor building acquires the grandeur of 20 stories." He must make the subject of his picture assume realistic, strongly appealing, four-dimensional proportions, and be ready to turn an abstract

Underwood and Underwood

Photo made at a trick angle, only a few feet from the floor, gives the impression that the model is about to leap from a great height

idea into a pictorial reality. If he cannot do these things he might as well step out; there are too many in the field who can.

Scientific research has in recent years brought to light many improvements in methods and materials, so that today for almost every idea that may occur to the commercial photographer there is available the means to realize it photographically. Lenses fast enough to catch the most fleeting expression on a model's face or take a fast snapshot of an indoor theatrical performance, films of a wide range of color sensitivity and speed, which, combined with an astonishing array of color filters and a variety of lighting apparatus, make it possible for the photographer to create as never before. Meanwhile, technicians are constantly striving to provide photographers with materials that must ultimately give them absolute mastery of all the problems of the craft.

Victor Keppler, of New York City, one of the "stars" of the profession, gives some idea of the commercial photographer's difficulties when he says that he often has to take as many as 600 "shots" in order to get the one perfect picture he wants. A simple cup of steaming hot coffee required the exposure of several hundred films to get it right. To photograph a half dozen strawberries he once had to pick through ten boxes full to find six good "models."

Mr. Keppler says that "food is much more temperamental (before a camera) than any live model," but with 200 degrees, Fahrenheit, caused by the light streaming down on a group of sausages, or on a dish of ice cream, is it any wonder that the one shrivels up and the other melts? However, the resourceful commercial photographer never says no to an assignment, no matter how tough it may seem. So he paints the sausages with oil just before the camera is clicked; he keeps the ice cream in shape by alternating layers of "dry ice" with layers of ice cream in a sherbet glass and wraps it in a towel for an hour, after which the ice cream is ready to face the intense heat for at least the few seconds necessary for the exposure.

Silver and other highly lustrous surfaces are the bane of the photographer's existence because they catch the gleam of the lights and reflect bright blotches. The photographer gets around this by dulling the surfaces and thus reducing reflectivity. Sometimes, however, he must adopt a much more elaborate procedure. Mr. Keppler once hired a special room to do a particularly important silver assignment. The floor was carpeted with black velvet to afford the necessary contrast to the silver pieces arranged upon it. The walls were hung with white Chinese silk to diffuse the light coming through. The camera was pointed from the ceiling, a small hole being provided for the lens.

Underwood and Underwood

An example of photomontage done on a single negative. The eyes are those of one person, who moved about to different positions under the direction of the photographer. It took ten separate exposures to complete this one negative

Similarly, when photographers were tearing their hair trying to devise means for photographing ice cubes in a glass, without producing a flat-toned picture, someone thought up the idea of placing a layer of hard coal back of the glass. This expedient served to outline the striations in the ice cubes and produced a picture that looked like the real thing.

A favorite method with the commercial photographers is the process known as "photomontage," by which a number of images are included in the same picture. As introduced from Europe, where it originated, the procedure was to photograph different units separately, then paste them up in the desired arrangement and retouch in order to blend all into one. This method is known as the process of "stripping" prints together. Advanced commercial photographers have abandoned this for what is considered the more satisfactory methods of either making all the exposures on a single negative or of making several negatives and printing them all together.

"Compositing," or the taking of separate photographs and then putting them together in such a way as to give the impression of a single picture, is another much-used expedient of the commercial photographer. It was this that saved the day for one photographer when he was asked to do what seemed on the surface an impossible task. His assignment was to get a view of the New York skyline looking through an arched window in the Lincoln Building at Forty-second Street and Madison Avenue, the window to serve as a "frame" for the view. As the arched windows were four stories high, it was out of the question to try to get a picture of the window from the inside, so the photographer went across the street to the roof of a neighboring building, where the height was about that of the arched windows in the Lincoln Building. Using a long-focus lens, he got a large image of one of the arched windows. To get his view of the skyline, he went to the roof of the Lincoln Building on a sunny day when the sun was shining toward the lens and, pointing his camera toward the Battery and the Statue of Liberty, got a picture which served as a "background" for the sunset which he had to go to the bank of the Delaware River in New Jersey to photograph. The first picture, that of the exterior of the arched window, was "doctored" to leave only the window frame, and the "composite" was made by printing the sunset over the hazy New York skyline.

Lon Chaney's make-up tricks served John Paul Pennebaker one day when he had to make a photograph that would demonstrate the idea that smoke holds back the running efficiency of an automobile. He sought and found a model with dramatic ability and fiend-like features, and another model with claw-like hands. He made separate photographs of the head and the hands of the two men. He then photographed a car, posing the models according to specifications and in suitably smaller proportions. Several pieces of glass were placed in planes before the camera, and upon them were arranged the pictures of the

head, hands and the car. The illusion of thick, rolling smoke was effected by placing absorbent cotton in such a manner that it would be out of focus and lighting it in a special way.

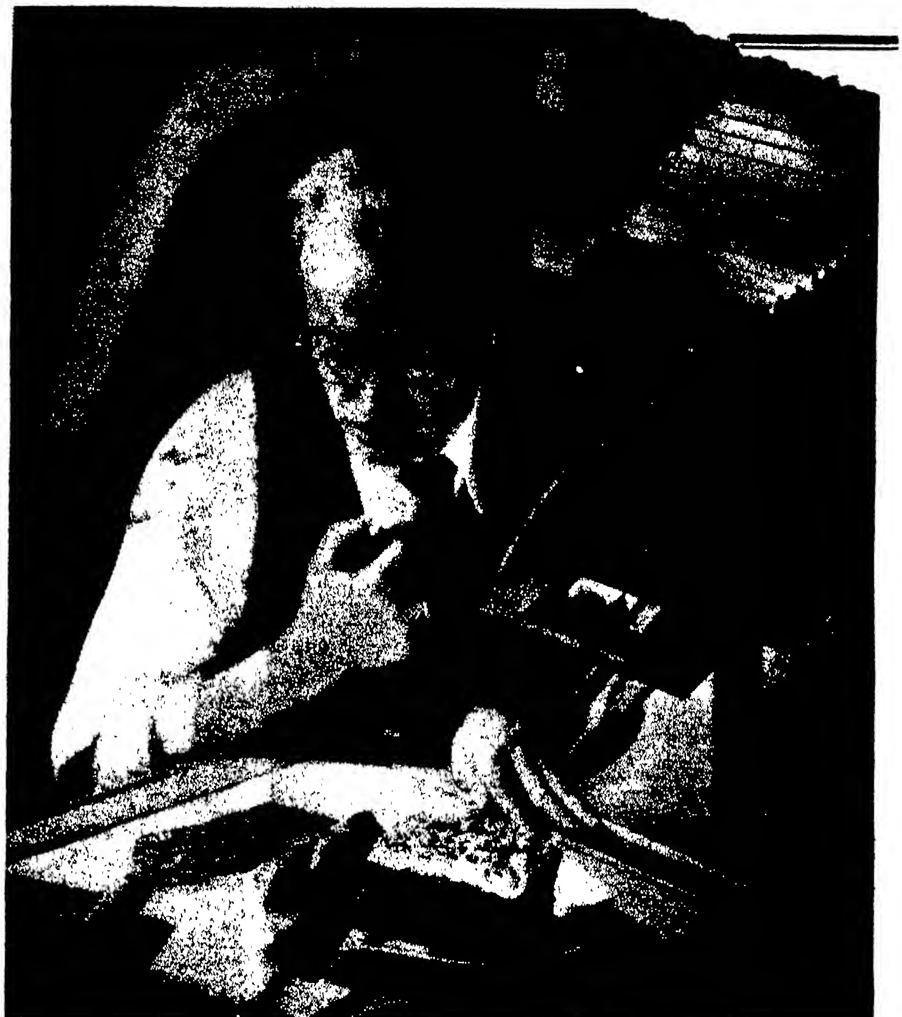
"Compositing" has been used in the case of pictures requiring the inclusion of persons who happen to be unavailable at the time. In such a case, a sketch is made up showing the different individuals in various poses about a central object, such as one of the company's products, and a copy sent to each of the individuals, who has his photograph made where he is and in the pose indicated. The pictures thus sent in are enlarged or reduced as required and in other ways retouched. A picture is thus produced as if all participants had actually been present at a single sitting.

Photomurals are being made in increasingly larger sizes. One of the largest on record is the one made last year by Kaufmann and Fabry Company, of Chicago, for the Ford Building at A Century of Progress. It is 600 feet long and 20 feet high, telling in 17 scenes part of the story of the Ford Motor Company. This photomural required nearly seven eighths of a mile of photographic paper 40 inches wide and consisted of 97 panels which took 40 men nearly a month to complete. The original photographs were taken by George Ebling, Mr. Ford's personal photographer. The work of enlarging, mounting, and the various construction details involved were completed by Kaufmann and Fabry.

So tremendous was the job that it was necessary to build a special apparatus and darkroom to handle the enlarging and printing of the mural, most of the work being done after midnight when steadier electrical current insured greater uniformity of results. The special enlarging machine built for the purpose used 7000 watts of power for lighting.

Framework backing for the panels required 14 tons of steel. Upon this steel work 12,000 square feet of Masonite was attached, requiring 11,000 screws and nearly 25 gallons of a special cement. Then followed the stretching on the framework of 12,000 square feet of special canvas, after which the photographs were mounted on the canvas, 200 gallons of paste being used in the mounting. Each panel, including framework, weighs more than 400 pounds.

An important phase of commercial photography today is color work, its principal contemporary exponent being Anton Bruehl, of New York City. Owing to the extremely difficult technical problems involved, Mr. Bruehl works in collaboration with Fernand Bourges, photographic technician, who has developed a special camera known as a "one-shot" camera, so designated because three negatives, each especially sensitive to one of the three primary colors, red, blue, and yellow, are exposed in the same instant.



Courtesy Schmidt Lithographic Company

Commercial photographers often find that food can be more "temperamental" than many live models. When subjected to the intense heat generated by brilliant studio lights, undesirable changes often take place, even in the comparatively few seconds required to obtain the correct exposure of the negative

"The rays of light reflected from the subject," Mr. Bruehl said in describing the process, "are split up three ways (red, blue, and yellow), going through three different filters to three separate plates, making three color separation negatives from the original subject."

The three separate 8 by 10 inch plates are then bound together and used simultaneously.

The necessity for getting the extremely sharp detail required for advertising color pictures, combined with the fast exposure needed to get natural expression on the face of the model and the additional difficulty presented by the increased exposure needed because filters are used, obliges the photographer to use an enormous amount of light. This is furnished by 50 to 300 Photoflash bulbs screwed in groups into sockets in large reflectors. These clusters of lights are covered with Cellophane as a precaution against accidents due to bulbs bursting because of the great concentration of heat caused by the proximity of so many powerful lights. No other light is used. Bulbs and shutter operate simultaneously, the approximate speed being about 1/50th of a second. Such "super snapshots" sometimes cost as much as 50 dollars each, which means that every shot must be perfect.

A total of about 600 amperes of electric current, believed to be a record for a photographic studio devoted to "stills" (as distinguished from movies) is available in the Bruehl-Bourges studio for the great array of various types of floodlights, spotlights, and miscellaneous lighting equipment they have at their command.

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Advanced amateur photographers will find, "between the lines" of the preceding article, much information that will be useful to them in their chosen hobby. Other specific articles coming in future issues will deal with candid photography, the correct use of exposure meters, theater photography with the miniature camera, and other kindred subjects.—The Editor.

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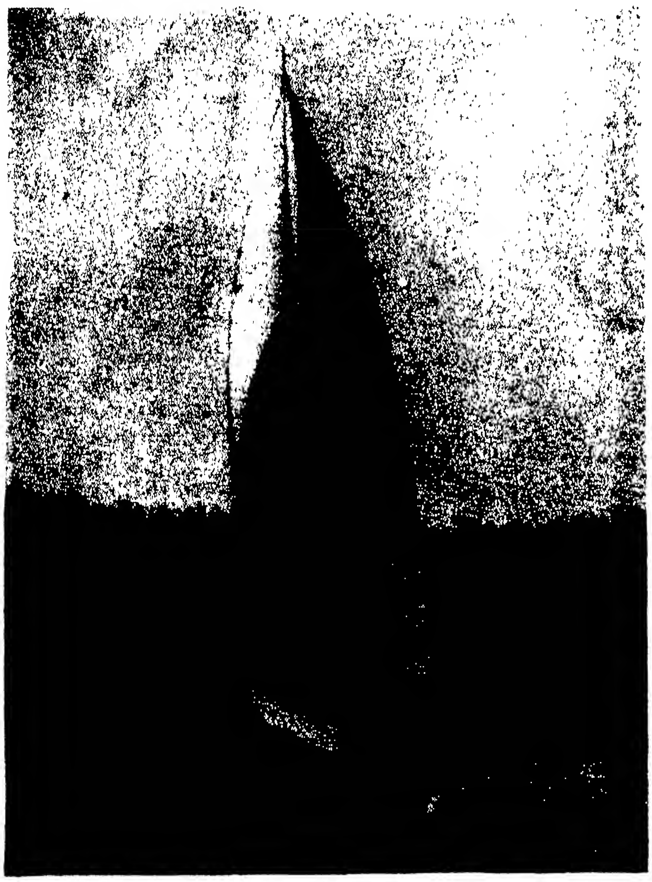
A HIGH-SPEED SAILBOAT

No Foresail Or Boom . . . Only One Mast Stay . . . Double Sail . . . Mast Rotates



The new boomless sailboat running before the wind, showing the double sail opened to give a parachute effect

PAGE the Ancient Mariner! Yachtsmen of Stockholm, Sweden, are discussing a new type sailboat without foresail, boom, or stays; a craft so fast that it has beaten larger rivals in recent tests; yet a sailboat so simple to handle that yachting experts expect that the rules of small boat racing may be changed to take advantage of certain of its novel principles.

Invented by Dr. Fredrik Ljungström of the Academy of Engineering Sciences, the new type boat has a revolving mast on which the mainsail is wound up like a window shade on its roller. To reduce sail area, as is usually done by reefing, the navigator simply turns a wheel at his elbow in the cockpit and rotates the mast by a system of ropes. Ball-bearing rollers support the foot of the mast. Regulations concerning revolving masts will have to be changed before this type of boat can be used in sanctioned racing.

The mainsail is triangular but double. Running before the wind the double sail opens out into what looks like a great parachute jib sail. For tacking into the wind one sail lies smoothly on top of the other. Aerodynamic streamlining is achieved in the sail by having its forward edge fixed in a slot on the bow side of the 46-foot pine mast. Thus there is no gap between the mast and sail as is found in ordinary sailing craft, and the over-all efficiency of the sail as a means of utilizing the power of the wind to propel the boat is greatly increased.

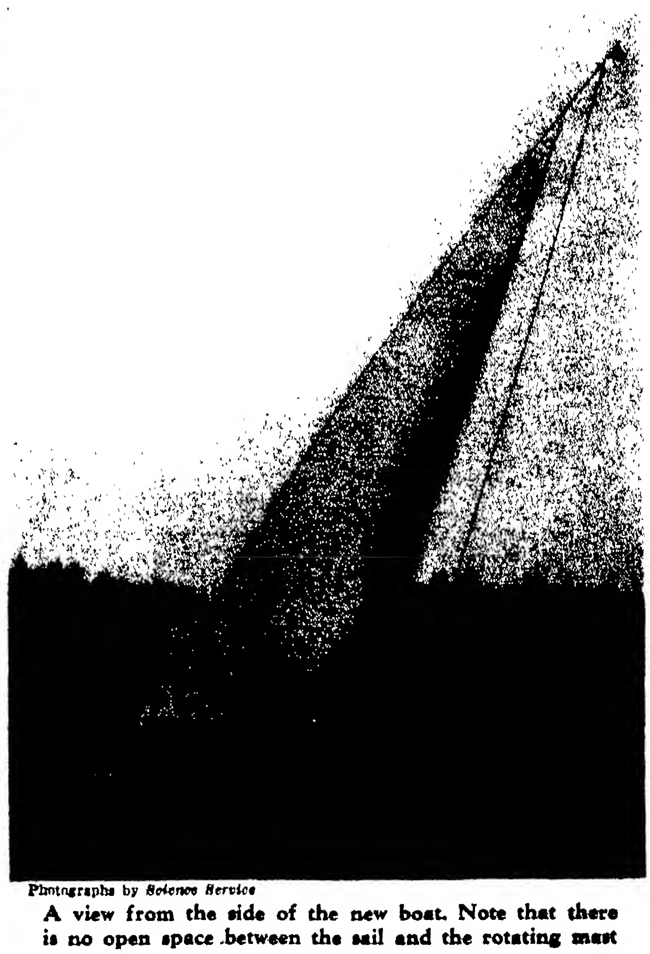
The only stay on the boat is a wire running from the tip of the mast to the stern of the boat. Such a lack of stays may arouse yachtsmen's suspicions but Dr. Ljungström has sailed his boat in heavy weather with excellent results.

The lack of stays is one reason for the speed of the boat. Stays—the fixed rigging which keeps the mast in position—have more wind resistance than is sometimes commonly believed. Although the surface area of the wires may be small they vibrate in the wind and hence greatly increase their resistance to a breeze.

For small-craft yachtsmen the new Swedish boat has the following advantages: 1. Less and cheaper rigging. 2. Sail cost reduced. 3. Fewer torn sails because of faster reefing. 4. Less danger of accidents to persons and sails caused by a swinging boom. There is no boom to swing.

Sail area of the new boat is 32 square meters, or about 10,000 square feet, when the two sails lie atop one another as in tacking. The sail area is 20,000 square feet in running before the wind.

Science Service's Swedish correspondent reports: "The boat is frightfully fast and has easily beaten larger boats against which it has sailed. Most amazing is the way the new boat beats up against the wind, quicker and nearer the wind than other boats."



Photographs by *Science Service*

A view from the side of the new boat. Note that there is no open space between the sail and the rotating mast

OUR POINT OF VIEW

Wanted—The Wisest Man

IF you had several millions of dollars to bestow, and had your choice of two clean-cut alternatives—to donate all of the money for medical research, or else to give it for the construction of the world's largest telescope—which would you choose, and why?

At a small gathering of outstanding medical men and a few laymen, a noted pathologist recently lamented the difficulty of obtaining funds for research on a serious disease, and made evident his disgust that, while funds were still needed for medical research, the astronomers had been able to secure millions to build a bigger telescope "just to look at the angels," as he put it. "Man's problems," he urged, "are *down here* on the earth, not up there. *This* is where we live."

This man's one-sidedness was perhaps quite natural, for he was wrapped up in a splendid program of research for humanitarian purposes, and the fact that he evidently regarded the expensive construction of a great telescope as frivolous is perhaps understandable in the circumstances. Perhaps the majority of persons, at least before they had given the matter more than a second's thought, would vote at once to donate the millions for medical research; it seems to be the more important.

But, on further thought, which things are the most important in life? Perhaps a better case can at least be made out for the telescope than would at first seem possible; in fact, the telescope might even win the argument in the end. Man once thought his whole world lay within his actual horizon. Later his nation was the whole world, while overhead were the stars—little lamps in an arched firmament just out of reach. The world existed, of course, for man's special benefit. Then came the invention of the astronomical telescope, by Galileo, and this extended man's mentally cramped little world to an undreamed of size. Subsequently the development of this remarkable instrument has entirely changed man's outlook and point of view on his world and on his own existence. He has partly learned his place in the universe, and is even hoping to learn about his meaning in it, and perhaps its own meaning. A greater telescope is a vital part of that great gradual process of man's emergence from his own ignorance, and those who regard this as the biggest thing of all would vote telescope.

But the real argument is one that probably cannot be decided, because neither side would accept the other's premises. It is essentially an argument in philosophy. It would be a lovely argument, a long one, and an instructive one. Start it somewhere and you will be more than likely to find out!

Yearly Toll

CARELESSNESS seems to be an ingrown American trait, or rather, a suppurative sore which no amount of doctoring seems to be able to retard. That imaginary man from Mars, visiting this planet and noting first the record of a long and excellent campaign that has been waged in the interests of safety, would be shocked beyond power of speech to learn that our 1934 national accident fatality record stood 8.7 percent higher than that for 1933. Accident deaths in 1934 were 99,000, only 300 less than the all-time high of 1930! Carelessness thus mocks civilization, makes a travesty of its ideals of progress.

Motor vehicles caused the deaths of 35,500 people, 4137 more than in the preceding year. A close second come deaths by accident in the home, totaling 33,000, which was 3000 more than in 1933. Occupational fatalities jumped 1000 to 15,000; while unclassified public accidents equalled the previous year's total of 17,500.

Part of the increase in fatal accidents in the occupational classification must have been due to increase in employment and the fact that workers, long unemployed, re-acquire their safety habits slowly. A large proportion of home fatalities fall under "excessive heat." But the increase in motor vehicle deaths is proportionately far ahead of the greater use of cars due to improved economic conditions. For 1934, motor vehicle registrations increased 4 percent over 1933, gasoline consumption increased 7 percent, while motor vehicle fatalities increased 13 percent. Drink accounted for part of this 13 percent increase, although the figures are incomplete; there are always too many unreported cases.

No doubt a good proportion of these accidental deaths—for example, those caused by weather—might be classed as unavoidable, but carelessness, recklessness, negligence caused most of the others. What makes these tragedies the more ghastly is the fact that innocent and careful people often are the victims of some fool who comes through unscathed. Were the person responsible for an accident the only one to suffer, the public might say a benediction at each such passing of a misfit through his own carelessness; for he would thus leave a world safer for others.

Bigger Ships

IN May, the world's largest liner, *Normandie*, will make her maiden voyage from France to the United States. Sometime later—the time has not been announced—the world's largest liner, *Queen Mary*, will make her maiden voyage from England to the United States. To American ears, how familiarly do the phrases ring. In succession, for years, we've heard: "from England," "from Germany," "from Italy," "from France," "from England"; and it's always "finest" or "largest," "fastest," "most luxurious," or "non-rolling." The persistent regularity with which they come to us is a tribute to the excellence of their owners' strategy for capturing American business—partly with loans from their various governments. More pointedly shameful to us, however: These ships are a reminder that we won't build ships to take care of our own ocean traffic and, worse, won't support the ships we have.

For years there has been much talk of building up our merchant marine. Yet we still are far down on the list. In a recent representative month Great Britain and Ireland headed the list with about 600,000 tons under construction; Germany, France, and Japan each was building more than 100,000 tons; and the United States had only 20,000 under construction. Needing ships as badly as we do, this is disgraceful. Over and above that fact, the industries which supply materials for shipbuilding, the many workmen depending upon shipyards for a livelihood, and thousands of seamen, all have suffered greatly by Americans' thoughtless support of foreign ships.

Under the circumstances, it should cause no surprise that, in certain quarters, there have been heard bitter criticisms of "nations that despise and belittle us, yet use our money, which they owe as war debts, to build monster ships to come after more of our money." It is too bad that such statements should be made; nevertheless it is up to us to support our own ships and, in time, build more so that we may keep our money at home.

THERE'S LIFE IN THE OLI

By **WILLIAM C. DICKERMAN**

President, the American Locomotive Company

IT so happens that I am the president of a corporation which has been building railroad power units for nearly 100 years. We have long been equipped, not only on the manufacturing but also on the research and designing side, to supply all of the power needs of our customers, whether they be for steam, electric, or Diesel-electric units. Therefore, since I can eliminate the temptation of prejudice from a business standpoint, possibly I can be objective in discussing railroad power problems.

Here, where I am requested to state the case for steam in few words, in order to get to the heart of the matter at once, I would begin with three primary observations:

First: Without the least question, each of these three major power units—steam, electric and Diesel- or oil-electric—has, and will continue to have, its place in our swiftly changing railroad transportation picture as a whole. Thus it goes without saying, yet deserves saying again, that the electric locomotive has some distinctive advantages, in congested areas, for example, where the largest possible track capacity is expedient and where, in tunnel operation, it is legally or otherwise required. It also has some disadvantages, notably its high initial cost, and its dependence, in peace and war, on large central power stations and transmission lines and, accordingly, its inability to go it alone, a characteristic which in pioneer days and in countless emergencies has helped to make the steam unit the most useful of all prime movers in history.

Nevertheless, it will be remembered that shortly after the turn of the century, when there had been more than one disastrous tunnel accident and electrification represented the first major contribution of scientific research to railroading, it was assumed in some quarters that all of our roads would soon be electrified; although now only 2400 of our quarter-million route miles are electrified.

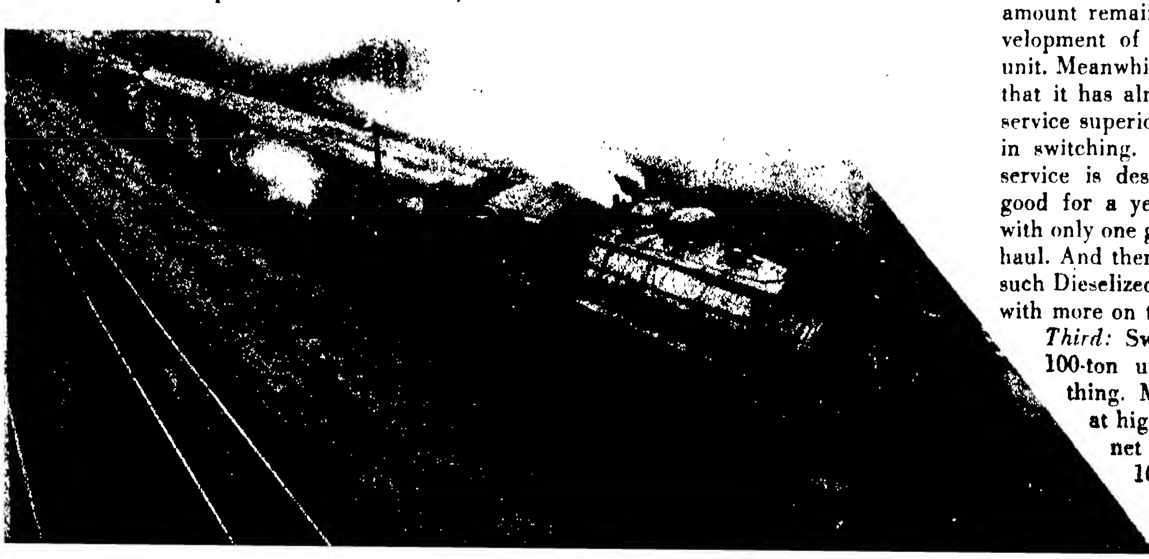
IT was indeed stated—September 20, 1907—in a meeting of the New York Railroad Club, by a manufacturer of electric units: "We do not need to say much in defense of the electric locomotive. It does not need any defense. My only fear is that we are going to be compelled to build electric locomotives faster than we can get facilities for doing so." And then came the prediction that the 47,000 steam units in use would soon be replaced by electrics and that many good steam units would go to the scrap-heap! Since then, nearly 60,000 steam units have been made in the United States for use in the United States!

Second: The Diesel- or oil-electric unit represents today another major approach by organized scientific research to railroad power problems, leaving the steam unit, in which more progress has been made in 20 years than in all the years before, to be heard from—a thought that leads me to say at once that the oil-electric might have had a much better chance to replace the steam unit 20 or so years ago.

To this new unit we, ourselves, and many other Diesel and electrical manufacturers, have devoted a decade, but only a decade, to adapt it to the uses and the abuses, and the limitations—in size and so on—inherent in railroad requirements. And, as railroad men all know, times without number inventor and laboratory findings of great promise have had to be discarded in the end, because the tests of day-by-day railroad operation in all kinds of weather, under all kinds of circumstances, with all kinds of operators, are so much more rigorous and unpredictable than those in any laboratory.

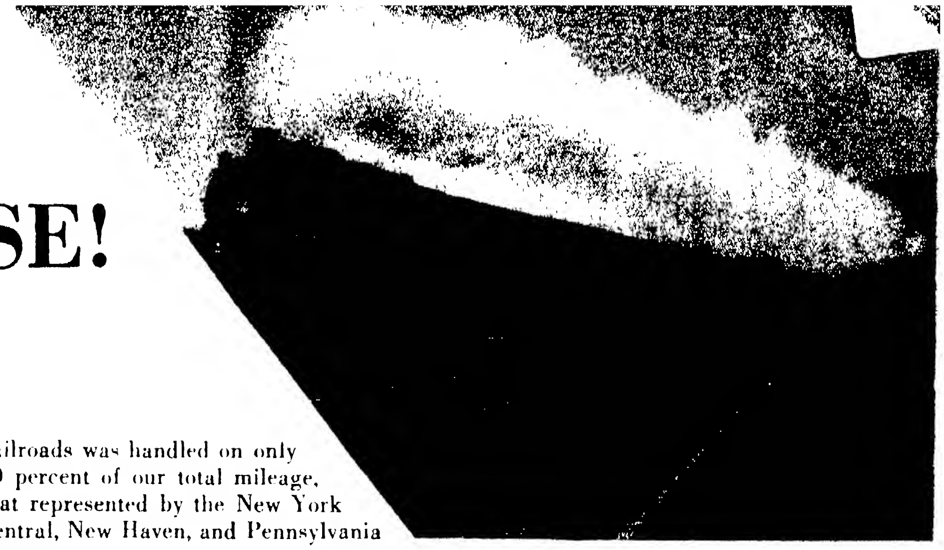
THE accompanying article by Mr. Dickerman, besides stirring in us memory of that romance of the rails we of an older generation felt as boys—we were set upon achieving that most enviable position of engineer at the throttle and be superior to ordinary mortals!—also is a splendid statement of facts and arguments for the steam locomotive. It is the first of three concerning railroad motive power. The other two—one which states the case for Diesels, by George W. Codrington, President of Winton Engine Corporation; and the other, on railroad electrification by G. I. Wright, Chief Electrical Engineer of the Reading Company—will be presented in the next two issues. While these three articles will be presented in sequence, the authors prepared their manuscripts independently. Therefore the articles give straightforward facts; they are not parts of a debate.—*The Editor.*

TRUE, a vast deal of progress has been made in short order, but a vast amount remains to be made in the development of this new railroad Diesel unit. Meanwhile, it is heartening to note that it has already demonstrated many service superiorities over the steam unit in switching. There, where continuous service is desirable, we provide units good for a year of continuous service with only one general shopping, or overhaul. And there, at this date, 150 or so such Dieselized units are already in use, with more on the way.



Third: Switching service, where a 100-ton unit is adequate, is one thing. Main-line freight hauling at high speed and perhaps with net cargoes of more than 10,000 tons, requiring pow-

IRON HORSE!



er units of 3500 to 4000 horsepower, is something else again. Although 60 percent of the steam locomotives of the United States are 20 years old or older, and, therefore, do not reflect the enormous progress made by science during the last 20 years, there has been great improvement in railroad freight handling throughout the country since the roads, badly disorganized and run down, were dumped back on their owners after the World War.

THE record is impressive and it gives great credit to steam, all the more since most steam locomotives are old and, as compared with new ones, are inefficient—so inefficient, in fact, that when one alert road recently replaced a fleet of steam units only 10 years old with new ones, it reported a saving on its investment at the end of the first year of 38 percent!

Further, since we must accept things as they are, our roads now have more than sufficient freight units, inefficient though most of them are, to get along somehow, in a time when economy is the impelling watchword. More to the point: Though some are promised, there is as yet no multi-motored oil-electric unit of required horsepower for main-line freight hauling in existence, let alone in service. Therefore it remains wholly debatable whether such a unit would stand up and whether it would be as efficient, in terms of fuel economy and all-round investment worth, as the modern steam unit, which costs initially not half as much and enjoys the unique distinction of being the simplest, most dependable, and long-lived of all overland power units. Moreover, under these circumstances, it would not seem to be either logical or reasonable to expect our roads, with their maintenance as well as their records and freight service predicated on steam, to provide special oil-electric facilities and experts to supplement facilities and mechanics required for steam units.

For all of these understandable reasons, it is to my notion simply inconceivable, at least until the unexpected happens, that the oil-electric can as yet find place generally in main-line railroad freight hauling. And, to go no further, this conclusion militates against its general acceptance in main-line passenger hauling, especially when freight hauling is the bread-basket of the roads. I find that in 1932, 41 percent of the total passenger revenue of our Class 1 railroads was handled on only 10 percent of our total mileage, that represented by the New York Central, New Haven, and Pennsylvania systems.

With these observations in mind, it would seem clear that the issue, Diesel-electric *vs.* steam, turns on passenger transportation, speed, and the comfort a necessary accompaniment of speed —which are involved.

At once I wish here to say that I personally feel a profound sense of gratitude to those roads and designers and manufacturing concerns serving them who approached the railroads' difficult passenger problem with a fresh viewpoint, made full use of all available contributions of science, produced the Union Pacific's *M-10001* and the Burlington's *Zephyr*, stimulated the production of other trains likewise new in kind, sensationally focused public attention on the railroads, and made them aware of public emphasis on speed, comfort, and all else that goes to increase the desirability of traveling by rail. These roads and these other pioneers, in my judgment, ought to be awarded Congressional Medals of Honor for the service they have rendered in energizing a new era in railroad travel! Nevertheless, here again I judge three points are in order:

FIRST: The records for speed made by the *M-10001* and the *Zephyr* must be viewed, and by railroad executives everywhere are, as special test performances made under special test conditions not ordinarily practicable in day-by-day railroad operation. It is not deemed economic to make long non-stop runs with small passenger loads or for any single train to side-track other through passenger and freight trains. Further, it is to be noted that of our 241,424 miles of Class 1 main track, only 36,677 is second track, 3162 third, and 2208 fourth.

Second: It goes without saying, on the side of passenger comfort, that such revolutionary, finely appointed cars as those of the *M-10001* and the *Zephyr* can be, and by the New Haven and numerous other roads are rapidly being provided for steam units as well as for Diesel-electric. In other words, particularly because air-conditioning removes the only remaining passenger objections to steam, it may be concluded that passengers in general will not know, and will care less in the future, which unit hauls them, if only they can travel as fast and as comfortably either way.

Third: Since the 90's and thereabouts, when such famous light steam locomotives as old *No. 999* exceeded 100 miles an hour for short distances, no attempt has been made until recently to approach, much less to exhaust, the speed possibilities of steam. In July, 1934, without special preparation, with a regular locomotive hauling a regular train whose car weight alone exceeded by fully three times the total weight of the *M-10001* with full load, a steam train on the Milwaukee Railroad readily broke all world railroad records at that date by covering 69.9 miles at the rate of 91.1 miles an hour. Recently the New Haven has demonstrated that, when given the chance, its steam units can safely and comfortably haul passengers at sustained speeds above 85 miles an hour.

MEANWHILE, and for the first time in American railroad history, the Milwaukee Railroad has ordered two relatively light, scientifically streamlined, new steam locomotives designed to haul relatively light but full-size trains at a cruising speed (a speed efficient in relation to fuel, maintenance, and long life) of 100 miles an hour. (As every one knows, the *Twentieth Century*, one of the world's fastest steam trains, is never permitted to exceed 70 miles an hour.) These trains will be operated between Chicago and St. Paul, a distance of 411 miles, each way, each day, including five stops. With 300 pounds of steam pressure, with 84-inch drive-wheels, of a type affectionately known to railroad men as a 4-4-2, but inwardly as well as outwardly of design totally different from the conventional steam unit, these locomotives, which we are designing and building in co-operation with the Milwaukee, will be the first steam locomotives ever built for speed in the light of present scien-

(Please turn to page 222)

THE EARTH'S WABBLING AXIS

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

ONE of the oldest problems of observation is to find the latitude of a certain place, and dozens of ways of solving it have been devised. In theory, it is very simple. We have only to take any one of the hundreds of bodies whose position in the heavens has been accurately calculated—sun, moon, planets, stars—observe it as it is crossing the meridian, and measure how far it appears to be from the zenith or from the horizon below it to the north or south, and then to do a simple sum in addition or subtraction. The navigator can "shoot" the sun with his sextant and do the whole job in three minutes, including all the necessary correction, and come out within a mile or less of the exact value—which is all one needs in the open sea or to pick up a lightship.

On land, with a telescope, some additional refinements have to be considered, but the theory is still simple. The most troublesome complication arises from the refraction of light as it passes downward through the atmosphere. A ray descending from the very zenith would be unaffected, but all those which come in at a slant are deflected—bent downward—so that the stars appear to be higher above the horizon than they really are. The amount of this "astronomical refraction" varies with the apparent altitude and also, unfortunately for us, with the state of the air, increasing as the pressure goes up and the temperature goes down. Every observatory where measures of this kind are attempted has therefore a barometer and a precise thermometer in the observing room. From the readings of these, and by the use of tables derived from thousands of observations in years gone by, it is a matter of a few minutes to calculate the refraction corrections with an accuracy sufficient for almost any purpose—though, as we shall soon see, not quite for all.

Until within the last 50 years, everyone supposed that the latitude of an observatory found from observations thus carefully corrected should be always the same. To be sure, the direction of gravity itself is affected by the attraction of nearby mountains, which slightly deflects that of the whole mass of the earth. But at a given station this effect is constant and can be determined only by connecting many such stations by a precise geodetic survey. The resulting information about the attraction of the mountains, and of their roots buried scores of miles below the surface, is of great interest to the geologist. But the astronomer, if he is busy observing the heavens, cares mainly whether his own zenith "stays put," even if somewhat shifted by local attraction.

To be sure, if he had the good luck to have his observatory at the foot of some great volcano that blew its head off, like Katmai, and lived to return after the catastrophe, he might find a real and permanent change due to the diminished attraction of the truncated peak. But, for obvious reasons, no such case has actually been recorded. In 1888, however, Küstner discovered that observations of the latitude of Berlin showed a definite variation, changing in a few months by more than half a second of arc. The agreement of observations during successive months shows that the change was undoubtedly real. This meant that the angle between the plumb line at Berlin and the earth's axis must change. Which of them moved?

THE question was soon settled by a special series of precise latitude observations made in Hawaii, almost on the opposite side of the pole from Germany. When the latitude of one station increased, that of the other diminished, and by substantially the same amount; hence it was the pole that moved.

Further study brought out the now familiar characteristics of this motion. Imagine a point moving about a fixed "mean pole," in a nearly circular curve about 25 feet in radius, with a period of 14 months. The "instantaneous pole" about which the earth is rotating at a given moment moves about the point in a narrow ellipse every year, but never gets more than just a few feet from it. The 14-month motion is a natural and inevitable wabble which might be expected in any body not exactly spherical in shape if it is not rotating about an axis of symmetry. It is nearly the same from one cycle to the next. The annual motion arises from the loading of the continents by snow in winter, the seasonal changes in winds and ocean currents, and other meteorological sources. It is not surprising therefore that the amplitude and shape of this curve change considerably from year to year.

Since the beginning of the present century a careful series of observations have been made, especially for the study of these polar motions. At first it was hoped that, when the laws of its motion had been found, the place of the pole could be predicted, making a continuance of the campaign needless. But the nature of the annual component defies such hopes, and now by common agreement the observations are to be continued indefinitely.

Many precautions are taken to secure the utmost accuracy. Observations are made with zenith telescopes—instruments to which very precise levels are attached, which can be set at any desired angle to the line of sight. A star south of the zenith is observed; then the axis is reversed in its pivots so that the telescope is directed just as far north as it previously was to the south, and settings made on another star as it transits the field of view. The level serves to secure this adjustment, or to allow for any minute difference between the two settings. A micrometer at the eye end measures how far the stars are above or below the line of sight of the instrument. In this way a very accurate determination can be made of the position of the zenith compared with the average of the two stars. (Suitable star pairs with accurately known declinations are, of course, carefully selected beforehand.) A great advantage of this method is that the troublesome refraction corrections are almost eliminated. The refraction shifts the northern star toward the south, but the southern star to the north, so that the average of the two is little influenced, though careful allowance is made for the residual effects.

In the international latitude campaign a series of stations was chosen, all in the same latitude, 39°8′ north, and equipped with instruments of the same type and size. They were strung around the world—in Maryland, California, Japan, Turkestan, and Sardinia—so that the pole could not move in any direction without approaching some of them and receding from others. Observations were made on every clear night, using the same list of stars at all the stations so that any minute errors which might happen to be in the adopted positions of

the stars would affect all the results alike, and disappear from the differences which revealed the motion of the pole.

Long and successful series of observations have been made ever since (except when war or revolution interfered) and the wanderings of the pole have been continuously followed so accurately that its position at any time, relative to the mean pole, is known to one or two hundredths of a second of arc, corresponding to one or two feet on the earth's surface. But in the course of the calculations a strange thing appeared. In addition to the unmistakable polar motion toward one direction and away from the opposite quarter, smaller changes appeared which affected all the latitudes at once in the same direction, swinging back and forth by a few hundredths of a second with a period of a year. This curious phenomenon, called after its discoverer, the Japanese astronomer Kimura, was a complete puzzle for more than 20 years. The pole could not move toward all the stations at once. If the center of gravity of the earth could move inside the mass northward and southward every year, this would deflect the vertical at all stations alike. But this suggestion is absurd: the tonnage of material which would have to be moved deep in the earth's core is preposterously great. The loading of the continents with snow does not shift the earth's center perceptibly, though it sets the planet wabbling and thus contributes part of the motion to the pole. Was the tiny additional effect also due to a real motion of some sort, or did it result from some subtle error which, despite all precautions, had crept into the observations?

THERE was one suspicious circumstance about the Kimura effect—its period. It continued to run through its cycle in just one year; that is, it followed the seasons. Now there are all sorts of terrestrial influences which do the same, and any one of them might be responsible.

Furthermore, when the study was made still more precise by correcting the observations at each station for the known effects of the motions of the pole, and separating out the residue, it was found that the anomalies at the different places were not really alike in behavior. The latitude appeared to be greatest in one month at one station, in a different month at another, and the curves showing the changes were by no means similar. A noteworthy instance of this appeared at Greenwich. This observatory is about 900 miles north of the parallel of the international stations, but careful observations for latitude have been made there for many years. The instrument employed, by the way,

How the Changing Snow Load, and the Winds and the Ocean Currents, Constantly Shift the Poles

is of a different type—a photographic telescope attached to a ring-shaped float which swims in a trough of mercury and should thus stand at the same level, however it is turned. Its designer, Bryan Cookson, an astronomer of great promise, died lamentably young, and the difficult technic of its operation was later developed and brought to complete success by a new member of the staff by the name of Arthur Eddington. He has now turned to other fields of activity—with what success all the world knows—but the once refractory instrument continues to give excellent results.

When the observations were looked up, and the conspicuous effects of the polar motion allowed for, a definite Kimura effect remained. It was very small, its whole range being only 0".04 (corresponding to four feet on the earth's surface!) but regular, having the maxima every year in February and August, with minima in May and November. At most other stations there was but one maximum and one minimum yearly.

This anomalous behavior has just been satisfactorily explained by the Japanese astronomer, Kawasaki, who had already interpreted in similar fashion the effects observed at the Japanese latitude station, Mizusawa. In a word, there is no real change at all. What is observed is a spurious effect depending on the direction of the wind!

Years before, the Greenwich Observatory had found that when the wind was in the north and east the observed latitude came out smaller than was otherwise to be expected, and contrariwise when it blew from the opposite quarters. Repeating these studies on eight further years' observations, Kawasaki finds that this conclusion is confirmed beyond all question. With the northeast winds the latitude comes out 0".06 too small; with a southwest wind, 0".04 too great, the changes for other wind directions being smaller but in regular progression.

NOW the wind at Greenwich, as at most other places, does not blow in the same average direction, or on the same number of nights in different directions, at different seasons of the year. Knowing the effect of a given wind on the observations, and the average number of nights in each month when the wind blew from each point, it was a matter of straightforward arithmetic to compute the average wind effect.

The resulting curve showed two maxima and two minima during the year, coming so closely at the same time as those of the Kimura effect that there can be no doubt of a real relation. The calculated wind effect however is only about two thirds of the observed anomalies. Some other disturbing factors may be at work, but the wind is evidently the chief culprit.

So far, so good, but why in the name of reason should the wind affect observations for latitude? The telescope is carefully sheltered and no direct disturbance is possible. But influences on refraction are another matter. In calculating the refraction we assume that the layers of equal density in the air lie horizontally—as indeed they should do over level ground and in still air. Suppose that something tilts these layers so that they rise higher toward the south of us and are lower to the north. The direction from which light may traverse the atmosphere without deviation is at right angles to these layers—under the supposed conditions it will be north of the zenith. Rays coming from directly overhead will now be a little deflected, causing a star in this position to appear slightly too far north, and the same will be true, as is easily seen, for the other stars on the meridian. Our instrumental zenith, derived without allowance for this, will therefore be too far south, and our deduced latitude too small.

NOW the Greenwich Observatory stands on the brow of a hill nearly 200 feet high, which faces off to the Thames on the north, while to the southward the ground is nearly level. A wind from the north, blowing uphill, might be expected to produce such an abnormal stratification in the air as has just been described, while one coming from the level to the southward might give a much smaller effect. Not only the existence, but the observed direction, of the wind effect is thus intelligible. It is not certain, however, that the abnormal refraction is produced near enough to the ground to be influenced much by the gentle topography of the London basin. Perhaps more extensive meteorological processes are involved, and a deal more study will be required before the matter is fully cleared up. The half-told tale, however, suffices to show how many are the trials, and how unexpected the successes, of the investigator who seeks to determine anything with all the accuracy of which human skill is capable.

Exploring Prehistoric

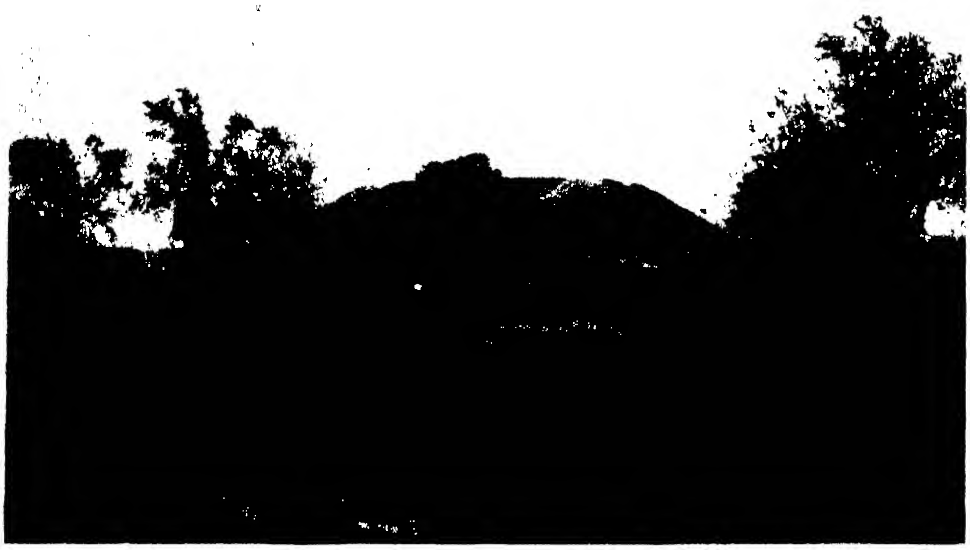


Figure 1: **Mound A is a really large mound, its level top being 175 feet square**

(*Part 2*)

MOUND C, described in the previous installment, lies on a low terrace of natural terrain east of the Ocmulgee River. Two hundred yards to the east of Mound C, across a narrow stream, rises the escarpment of bluffs marking the early geological confines of the Ocmulgee basin. The bluffs run northeast and southwest, curving sharply with the bend of the river near Macon. On the flat crest of these bluffs a level plateau or tableland provides the site of several mounds and a considerable area of prehistoric village site occupation.

Mound A is the most striking feature of archeological interest on the plateau east of Macon (Figure 1). The bluffs stand 40 feet above the river plain and the mound rises 45 feet above the plateau. Both length and breadth dimensions exceed 300 feet. Mound A towers above its satellite mounds and the surrounding country, a picture of grandeur and imposing splendor serving as a monument to the industry and engineering skill of the prehistoric Indian architects who conceived it.

The massive strength and solidity of Mound A stimulate the imagination and enthusiasm of laymen and archeologists alike. It brings to mind pictures of other imposing tumuli famous in the annals of archeology: Monk's Mound in East St. Louis, Illinois, the largest mound pyramid in North America; distinguished mound groups in Ohio, centering about the unique Serpent Mound; the stratified pile of buried cities and cultural debris constituting the site of Troy in Asia Minor.

Mounds of this type are not regarded by American prehistorians as having been constructed primarily for burial purposes. In Mexico and Central America, higher culture centers of the New World, similar large flat-topped, pyramidal mounds were mantled with stone rubble. Distinctive civilizations expressed themselves permanently in stone temples, public buildings, terraces, stairways, ornately carved balustrades. The fundamental assumption is that similar pyramids in North America were the sites of important ceremonial and public buildings also, but that the mound-building civilizations north of Mexico built in wood, supplemented with baked clay daubed on reed and wattled lattice construction. This medium of construction in early American aboriginal architecture to the north makes neither for permanence nor for elaboration and less of it usually remains to be uncovered and reconstructed under the trowel of the archeologist. The adobe and sun-dried brick apartment towns of the southwestern Pueblo Indians are an exception.

The wooden temples and buildings of the mound areas have long since disappeared. But the huge pyramids remain, silent witnesses to a past glory. When one comprehends the magnitude of the engineering tasks involved, and the labors required to transport materials to erect such large earth piles, he experiences a feeling of awe and admiration. These were the "sky scrapers" of pre-Columbian America. It is easy to understand the source of the popular notion, an idea that has found some support in romantic and pseudo-scien-

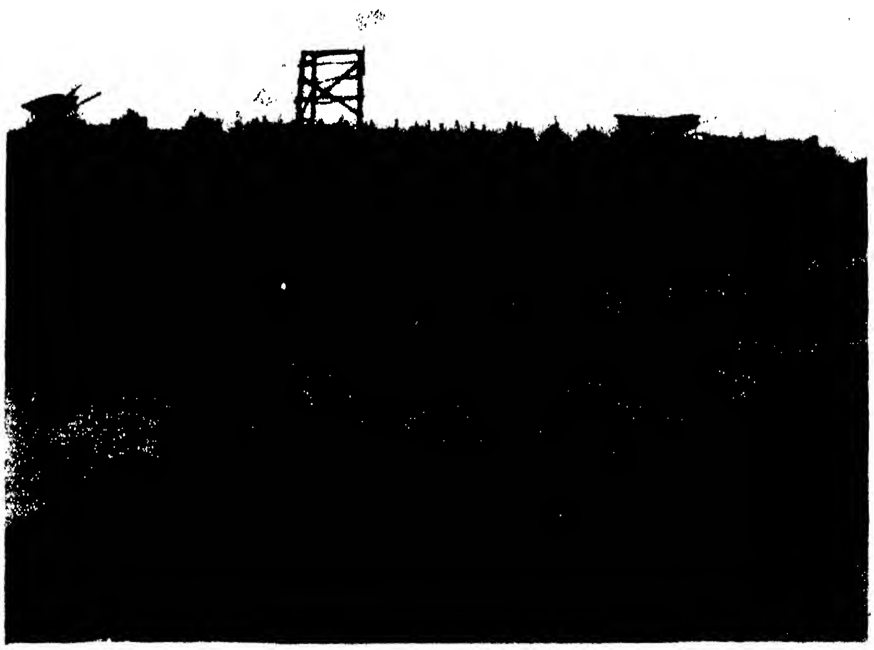


Figure 2: **Indian cornfields like this are still discernible in many regions**

GEORGIA

Massive Mounds Stimulating the Imagination . . .
Moundbuilders Were Simply Ordinary Indians . . .
Prehistoric Cornfields . . . Ceremonial Houses

By A. R. KELLY, A.M., Ph.D.

tific writings, to the effect that the mound builders were a higher cultured people not belonging to the race of the American Indian. The general conception of the wretched, hard-bitten, culturally impoverished blanket Indian of colonial days has a wide currency. Lo, the poor Indian!

Mound A is too huge to permit of exploration by any ordinarily appointed field expedition. A near-regiment of men, a large archeological staff composed of both engineers and archeologists, with a generous money subsidy, would be required for thorough investigation.

A shaft was sunk from the summit to the base of the mound to obtain cross-sections of internal structure. The shaft was 15 feet long and ten feet wide. It was cribbed all the way down, as in ordinary mining operations. At a distance of 30 feet from the surface it was found necessary to abandon the shaft as unsafe for the workmen. Basket-laid sand in the body of the mound slipped, exerting a lateral pressure against the cribbing and endangering the lives of the men working in the pit.

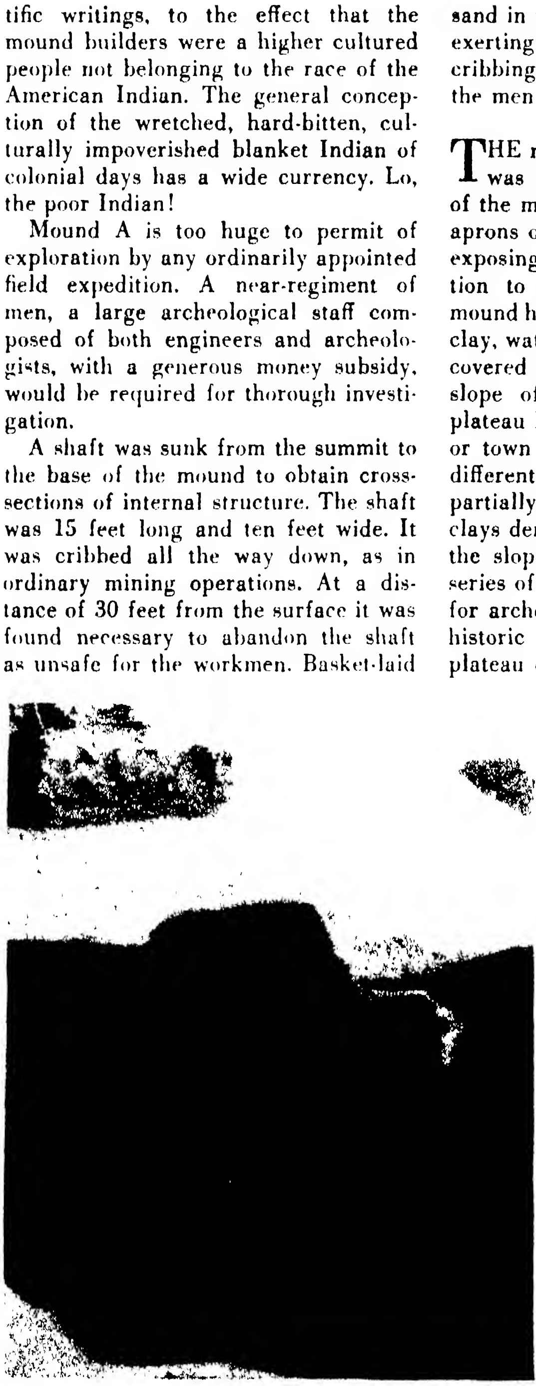


Figure 3: One of several clay lined pits on Mound D, probably used for storing corn

THE new plan of attack on Mound A was to sink trenches into the sides of the mound, through the terraces and aprons of the mound to the north, thus exposing the basal structure and relation to the plateau upon which the mound had been built. Timbered, baked-clay, wattle-constructed houses were uncovered by these trenches beneath the slope of the mound on the original plateau level. Other evidences of village or town occupation were uncovered at different levels above the plateau floor, partially covered by stratified sands and clays derived as washed materials from the slopes of the great mound. These series of levels provide a tentative basis for archeological reconstruction of prehistoric settlement on the bluffs or plateau east of Macon. The chronology is now in process of making, as pottery, stone artifacts, house floors and walls, and other evidences are uncovered.

A quarter of a mile north of Mound A, across two railway cuts made through the plateau by the Central of Georgia railroad, is the site of Mound D. Here have been uncovered probably the most striking of the discoveries made during the course of explorations in the Ocmulgee basin.

Mound D in itself is not a particularly imposing mound, from external appearances. About ten to twelve feet in height, oval in shape, flat-topped, with dimensions approximately 125 by 150 feet, this mound is interesting primarily for the important archeological situations revealed inside it.

The most striking fact about Mound D relates to the discovery beneath the base of the mound of a prehistoric cultivated field. The mound builders had constructed Mound D immediately over the site of an abandoned corn field, thus effectively sealing or trapping the cultivated plot of ground from the weathering and erosion of a thousand years or more.

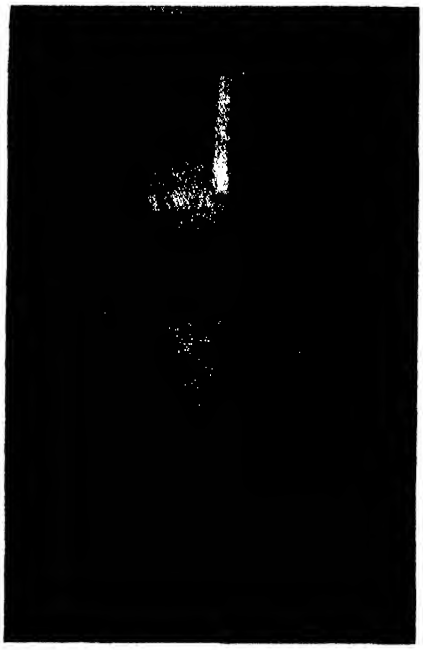


Figure 4: A basin of clay which was found on the slope of Mound D

When the mound soil is slipped off by the workmen, at the mound base the drilled rows or furrows show distinctly, running in uniform, parallel lines, the hillocks for corn culture spaced regularly at intervals within the alinement of the corn rows. (Figure 2.) Paths are seen clearly running across the prehistoric field, dividing the cultivated area into small patches.

WITHIN 50 yards of the cleared area where excavations through Mound D have uncovered the prehistoric field, modern corn planted by a negro tenant farmer has recently been growing. A path made by CWA workers cut obliquely through the modern corn field, giving a remarkably similar effect to that produced by the arrangements of paths and rows in the prehistoric field.

Cornfields of historic Indian tribes have previously been preserved and studied by American ethnologists, but the discovery at Macon is especially interesting because it is the first recorded instance of a definitely prehistoric cultivated field preserved for scientific records in the New World. The find is also important in suggesting that the early colonist in the southeastern United States not only took over maize as a domesticated plant but also continued methods of planting and arrangement of fields in much the same manner as that practiced by the Indians.

Figure 5: **What the removal of but three feet of clay revealed near Mound D**

ture on top of Mound D has led us to catalogue this site as the "Granary."

A basin of sun-dried, puddled clay found on the slope of Mound D has given rise to numerous conjectures as to its purpose (Figure 4). The rim of the vessel has been partially broken away, probably as the result of modern plowing over the village site. The original form of the basin must have been very similar to the wash bowls familiar to many boarding house and country hotel patrons.

Approximately 50 feet southeast of Mound D a small knoll of red clay, 50 feet in diameter and raised three to four feet above the surrounding plowed field, appeared to the suspicious eyes of the archeologist in charge of Mound D exploration to be something more than one of "the red hills of Georgia."

In the North Atlantic states such orderly arrangement of cultivated fields in rows, drills, with the hillocks showing only as undulating, hummocky swells in the furrows, are not found. In Maine, for example, colonial examples of corn culture followed the Indian custom of planting in separate hillocks, each swell of earth nurturing a plant, manured, hoed, and tended as a unit by the cultivator. It seems probable that two methods of corn culture have grown up independently, one in the north, one in the south, each borrowed from the Indian aborigines by the early white colonists.

THE discovery of a prehistoric corn field in central Georgia confirms to some extent the anthropological assumption that there is a cultural correlation between the cultivation of maize and the pottery making complex. Nomadic, hunting, semi-sedentary tribes were not agriculturists. They seldom made pottery. Just how complete is the correlation between maize culture and pottery making has not been determined. The find at Macon, antedating de Soto by at least several hundred years, gives scientific data for linking these two items in aboriginal American civilization.

Mound D produced several archeological situations of more than ordinary interest. On top of the mound, in exploring the surface soil for evidences of historic occupation, an area of baked clay mantling house debris and post hole indications of timbered walls was found. Subsequent exploration has revealed that this structure was of wattle and clay-daub construction. The sun-dried clay still carries the imprints from contact with reeds and small saplings used to make the supporting framework of the walls and roof. Such clay molds, often tempered with grass or vegetal fiber and bearing reed or wattle imprints, are known technically as briquettes.

Figure 6: **A little deeper digging at the site shown at the top revealed this**

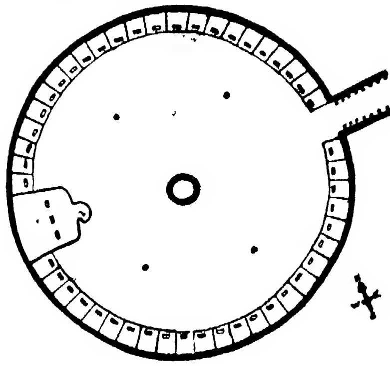


Figure 7: **Plan of the ceremonial chamber shown above and opposite**

In the floors of the square, reed-thatched, clay-daubed house on top of Mound D were set six or seven pits lined with baked clay (Figure 3). These cache pits were 24 to 30 inches in diameter and a foot or more in depth. They seldom were found to contain anything of archeological significance, not even the usual refuse found in pits around Indian villages. The theory is that they were used for the storage of corn. Their presence within the house walls of the struc-

The red earth was sliced off horizontally with shovel and trowel. Soon a perfect circle of baked-clay wall, with a diameter of 42 feet, showed in the carefully shaved flat profile (Figure 5). Two round, U-shaped clay buttresses (see Figure 6) marked the only break in the continuity of the ring of baked clay. These marked the entrance (Figure 7) to a round chamber mounded over with red clay loam.

Further stripping of the overburden of red clay sod uncovered heaps of baked clay, briquettes, and charred roof timbers. As the trowelmen brushed away more house debris the floor plan began to appear (Figure 7). Low, clay-moulded seats, large enough for only a single individual to sit upon with his legs drawn closely beneath his body, Turk fashion, were now exhibited, ranging the inner circumference of the underground chamber. A deep fire pit of baked clay was found in the center. Four large post holes filled with house debris indicated the main supporting timbers of the roof. The charred rafters had fallen in place to the floor. The

fire which had destroyed the ceremonial chamber had been smothered by the falling in of the earth-mounded roof when the supporting roof poles gave way.

On either side of the clay-buttressed entrance, the seats, 23 on the right, 24 on the left, rose in a perceptible hierarchical arrangement of increasing size and higher levels above the floor, to converge upon a central platform or dais upon which three larger and more comfortable seats were moulded for the masters of ceremony. See Figure 7.

Each of the 50 seats had a small oval, dish-shaped depression hollowed out toward the front (See Figure 6, also Figures 8 and 9). Considerable speculation has developed in attempting to interpret the meaning of these small basins in front of the seats. Ethnological data regarding the appointments of historic ceremonial houses of southeastern tribes afford no clue. The dish-like receptacles, like other features in the earth lodge, have no exact analogue or parallel. The most likely theories to date imply their use to hold the ceremonial paraphernalia of the seat occupants, or as small fire boxes in which coals from the central fire were kept warm and glowing.

THE only entrance to the ceremonial chamber was a low, narrow tunnel, 12 to 14 feet long, walled with log uprights. The log moulds, with charred portions of the original wood preserved in sections of the tunnel, still show on either side of the passageway.

One of the most unusual features of the ceremonial earth lodge at Mound D was the zoomorphic form and symbolism of the raised platform or dais set at the back of the chamber, directly across from the entrance and central fire. The platform was built to represent an eagle; the body, neck, head, curving beak, and eye are clearly defined (Figure 8). A peculiar stylistic treatment is given the eye symbol, a broad ellipse terminating in two downward projecting prongs. The prehistoric Indian artists of the southeastern United States often represented the eye of the eagle in this manner in decorating pottery and in engraving shell ornaments and copper plaques.

The essential architectural details of walls, supporting framework and floor plan of this prehistoric ceremonial chamber are so well preserved that it is possible to draw a picture of the structure as it must have been originally. Mr. Francis Etheridge, staff artist of the Macon Mounds expedition, has made rather striking pen and ink sketches of the reconstructed lodge and these are reproduced in Figures 9 and 10.

The interior aspect (Figure 9) shows the floor and wall, as uncovered by archeological exploration. The four supporting timbers were indicated clearly enough by postholes ranged equidistant from the central fire in the floor of the lodge. The details of roof and smoke hole may deviate slightly from the original structure, but there can be little doubt but that the chamber looked very much as the artist has reconstructed it.

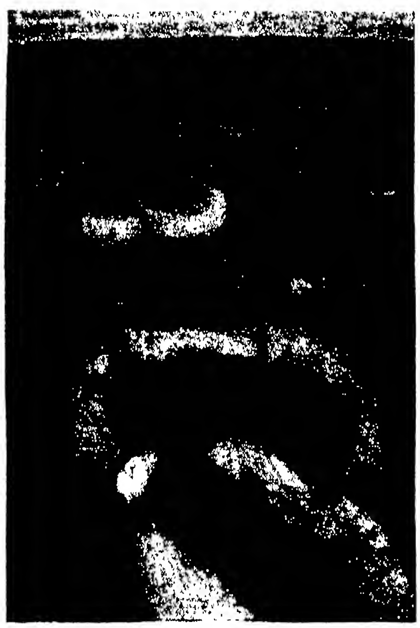


Figure 8: **The eagle mentioned in the article is shown upside down**

From the outside (Figure 10) it is certain that the lodge must have looked very much like a small knoll of ordinary Georgia red earth, except for the smoke hole and tunnel entrance leading in.

VISITORS to the southwestern Pueblo region of the United States will be struck by the superficial resemblance of this underground chamber in central Georgia to the subterranean religious structure of the southwest, the kiva.

Both scientific and lay observers have noted the resemblance. Perhaps the similarity is not as superficial as might be supposed. Future archeological exploration of early ceremonial structures is needed in both the southwest and the southeast before the full implications of the Macon discovery can be made out.

The earth lodge at Macon does depart in a number of essential features from the characteristic structural details of the typical kiva. It was not excavated in natural terrain, as are the kivas and other western subterranean type houses. A mound of red clay loam was made, scooped out to form a circular chamber, the walls daubed with clay and allowed to harden in the sun. Subsequently a roof covered with sod was built over the chamber and passageway. Moreover, the deflector, *sipapu*, ventilator shaft, banquettes, and other southwestern traits are not present. Yet, nevertheless, the structural affinity of the Macon earth lodge is closer to earth lodges of the western United States than to the type of council and ceremonial houses described by early ethnographers for Indian tribes resident in the southeastern section of the country.

(To be continued)

Figure 9: Below: **The artist's reconstruction of the inside of the Indian ceremonial house shown on the opposite page**

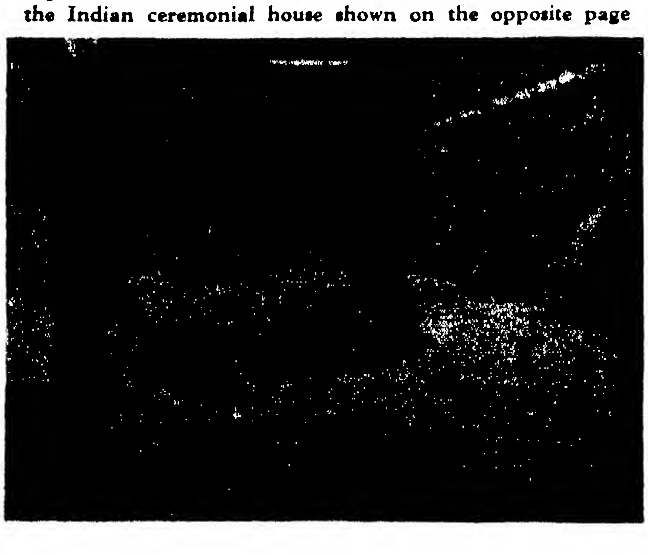


Figure 10: **Covered with earth and smoking at the top, the ceremonial house must have resembled a miniature volcano**

The Sanity of Insanity *or* The Insanity of Sanity

Understand Insanity . . . The Pleasure Principle . . . "Poor Devil, He's Sane" . . . No Desire to be Cured . . . Having a Perfectly Wonderful Time

By G. H. ESTABROOKS
Professor of Psychology at Colgate University

I HAVE an interesting file in my office. It contains, among other things, a pamphlet written in excellent English outlining the world's most novel plan of salvation. Entitled, "The Divine Thrill," it explains that the thrill we receive when our soul is saved is exactly the same as that experienced when we have goose pimples. So the great road to salvation lies in the cultivation of the art of raising goose pimples. Simplicity itself. Another sheaf of typewritten paper, entitled "Von Schlichtenberg, God," tells how the author, through the payment of two dollars and fifty cents to the United States treasury, was empowered by Congress to assume all the rights and titles that go with supreme majesty. Still a third treatise promises wealth and fame to its writer if he will complete a great invention according to the plans given. The invention is a cake of flying soap for use in a shower bath!

Now choose ye, before reading further, as to who were "insane," because choice is not easy. The first paper was by one who died a respected member of his community, loved for his altruism but thought a little "queer" by some. The second individual is confined in an institution for the insane. Examination reveals him as a case of general paresis—syphilis of the brain. The third, he of the flying soap, is in another institution, but the examinations to which he is subjected are in such fields as history or economics. He is a university student who has the gift of automatic writing—he is an amateur spirit medium—and this "invention" is characteristic of the weird ideas which his spirit control sends through.

To understand insanity we must realize that all men are seekers and all have but one goal in sight—happiness. No two choose the same route and the end of the way is often shrouded in pain and misery, but the original goal is the same. Napoleon could not be happy with all Europe under his sway, and St. Helena ended his quest. The criminal in Sing Sing arrived there in pursuit of happiness, and the hobo is as he is because he enjoys it. The average citizen has followed a dream of happiness to his present status and his future course, lead where it will, must be guided by this motive. We call it the "pleasure principle" in psychology.

STRANGE as it may seem, the insane, of all people, are sane, if we would judge simply by the success of this great quest. As a group they are supremely happy. Consider the typical "Napoleon" of your local insane hospital. He *is* Napoleon, in his own mind. He will write a check for 1,000,000 dollars or give you a duchy in France for the asking. To be sure, the National Bank or the French government might not treat him very seriously but in his own mind he is very wealthy and very powerful. "Poor devil," you say, "he's crazy."

But consider your own possible case. You strive hard all your life to get some small savings and become mayor of the local town. Then you are thrown out of office when the country goes alphabetical and your fortune is absorbed by the local bankster. If our Napoleon would condescend to gaze on such a worm as yourself he might well say, "Poor devil, he's sane."

We need no special psychology for the insane. Their minds work the same as our own, only more so—or less so. In the following pages you will see yourself in one of those funny circus mirrors. It may distort and exaggerate but through it all you will recognize the original of the caricature. There, but for the grace of God, go I.

MAN starts early and learns very fast. That is the reason for our insane hospitals. In this respect man is at a great disadvantage contrasted to the dog or cat, which rarely go insane. We can, however, teach them to be crazy. It would be quite easy to treat a dog so that he would bite you when you patted him and wag his tail when you stuck him with a pin; so that he would live on a diet of putrid fish and refuse fresh meat; so that he would go to sleep in a mud puddle and reject a dry kennel. These cases are quite possible, as we know from animal literature, but are not usual.

The animal goes through life with his original drives very little altered. He is like the French kings of whom it was said, "They learn nothing—and forget nothing." But the human is cursed with too much brains and, despite the prevailing notion of college students, the average man learns far too much for his own good—and often goes insane to prove it. "Dumb! Why that boy is so dumb that if he broke his leg the S.P.C.A. would want to shoot him," said Professor X.—but he was wrong. Man builds certain *desires* on the basis of his original drives, by means of mechanisms which we will explain, and these desires are very definitely learned. In fact,

about all of man's activity is based on these learned reactions—and he learns too much.

Psychology would say that the same child could be equally well trained to be a bolshevik, fascist, loyal adherent to King George, the Emperor of Japan, or Huey Long. Our like or dislike for Negroes, Republicans or Democrats is wholly the result of learning. Our tastes in art, music, literature, and our lack of taste in movies, are not born in us. Finally, when the strain of keeping abreast of the latest changes in football rules or N.R.A. codes becomes too great and we go "insane," it is the result of our environment and not because it was "in the family." Psychology no longer accepts the idea of heredity in mental disease.

WHAT actually happens is as follows, and we need use only the simplest of concepts to get a very fair idea of the subject. The human brain is something like a camera—only it has one great advantage over your Kodak. It has an automatic sensitizer for which the Eastman people would pay a fortune. The sensitizer is emotion of any kind. Under the influence of emotion the photographic plate in the brain becomes many times more delicate to outside impressions. The stronger the emotion the more sensitive the camera becomes. This serves a tremendously useful purpose, for the great lessons we have to learn are those connected with danger and other emotions. You may tell a child of five that eight times nine make seventy-two until you are blue in the face, and have no effect. The dog next door growls at him just once and he never forgets it. This is as it should be, for danger must not be overlooked. A child without fear would be a potential corpse.

Unfortunately, emotion is a two-edged sword. Under its influence we sometimes learn things which look quite unreasonable. For instance, a child cuts its hand, and is taken to the doctor, who sews up the cut without an anaesthetic. Needless to say, the child is badly frightened—the brain is sensitized for impressions. His attention is concentrated on the black bag from which the doctor takes the instruments. Later in life comes out a phobia—fear—of black bags! This impression was burned in at the time of the operation, and associated with fear. For the rest of his life he will always have a horror of black bags. A minor case of insanity, but one which is very easy to understand. So, indeed, are all these instances.

For example, a child is taught bad sex habits by a man who also teaches it to steal. The sex excitement supplies the emotion and on the sensitized brain is printed indelibly the idea of stealing. Result: the kleptomaniac who will steal worthless articles under the very nose of a policeman. Similarly we get the pyromaniac who loves to set fires, and various other curious states. A child found himself confined in a narrow, closed alleyway with a ferocious dog and was badly frightened. The result, strangely enough, was not a fear of dogs but claustrophobia, fear of closed places. An artilleryman during the war was turning the elevating wheel on his gun when a shell struck it and killed everyone but himself. The result here was an inability to stop his arm from rotating, for his mind was occupied with this action at the moment of intense fear—at the moment when the brain sensitizer was working hard.

Illustrations courtesy The Metropolitan Museum of Art

In Bedlam. From an engraving by William Hogarth, in "A Rake's Progress" (Plate VIII), published in London in 1735

The foregoing cases are very easy of explanation and represent the milder forms of insanity. We call these lighter types of mental disturbance neuroses. They are not always due to the pleasure principle and are not generally found in hospitals for the insane, since they are not a menace to society but can take care of themselves. The individuals whom we regard as "crazy" are usually those suffering from a psychosis. Here the individual cannot care for himself and is very often a menace to his fellow man. Yet, strange as it may seem, his actions are very logical, once we realize the cause behind them. Indeed, these severe cases of insanity are far more reasonable in their conduct, once we understand the "why" of it, than are the others.

Here, however, we have to invoke the pleasure principle which is necessary to the understanding of real insanity. It is almost self-evident in its workings. For example, in the physical field man will not deliberately walk on a tack. He will always seek pleasure and avoid pain. To be sure, he may undergo immediate pain willingly, as in the case of the dentist's chair, but this is for the sake of a future satisfaction.

The psychologist would claim that this pleasure principle also works in the realm of the mind. We think of the pleasant and avoid the painful. You immediately say that is not correct, because some of your thoughts are very unpleasant. This may be true, and yet, if you examine them carefully you will find that the great majority of these unpleasant thoughts really yield great satisfaction along some lines like the following. You think of an insult, which is perhaps unpleasant, but you also plan revenge, which may be very pleasant. Your financial conditions and family worries since 1929 may give you just cause for concern but along with it comes the feeling of self pity or the picture of yourself as a struggling hero—either of which may give you great satisfaction. However, we would not maintain that *all* thoughts are pleasant; merely that man has a strong tendency to think of the pleasant and avoid the unpleasant.

This so-called pleasure principle is the key which unlocks the mystery of insanity in its more severe forms. It is in respect to the satisfaction of this universal human search for pleasure that we say the insane are sane. They, of all people, have learned how to avoid pain and find pleasure. For example, let us take the case of an individual suffering from dementia praecox. These people are the most common of all the insane and are quite incurable. In a typical example the man will sit in a corner of the room all day, talking to himself, smiling at times, quite satisfied with the world. Speak to him and he probably will not answer. Should he do so you will have a marvelous explanation of how his insides are of solid gold, or that he is in radio contact with Mars, or that he is Alexander the Great confined here by his enemies. He may even offer you all Persia if you'll help him escape.

BUT note that he is really happy. He is living in a world of dreams but these dreams are very real. For that reason he is incurable. He enjoys being insane and, with all due respect to yourself, intends to remain that way. The worst offence you could possibly commit would be to effect a cure. This condition is basic to a majority of our abnormal

cases and is a natural outgrowth of the pleasure principle. The insane, the hysteric, the criminal, the pervert, and many other types are as they are because of choice. They do not wish a cure but only protection from the consequences of their acts. Someone defined remorse as "the penalty of being found out."

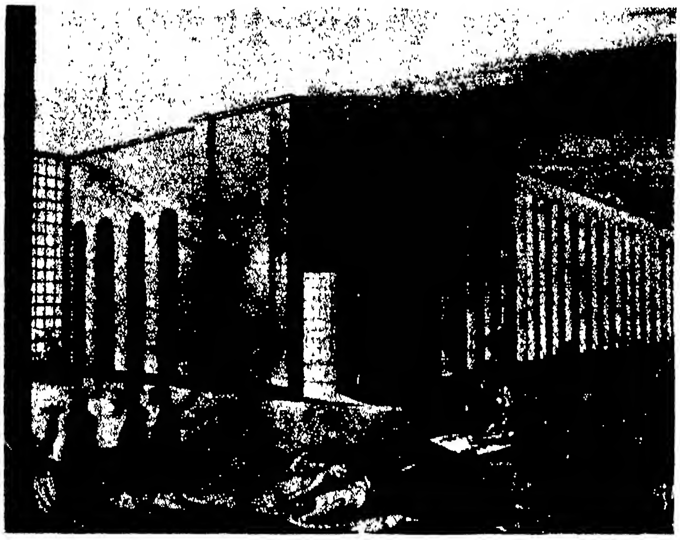
We can readily see why mental disturbances based, as the above, on the pleasure principle tend to be numerous, severe and incurable. The child who cut his hand or was frightened by the dog did not enjoy it. The experience was burned in, but the individual will not willingly repeat the original. The boy will not go around cutting his hand just because he enjoys having it sewed up. Neither will he seek out fierce dogs for the fun of being bitten. Yet that is just why the really insane frequently stay that way.

THE original experience was very pleasant, for there are pleasant as well as unpleasant emotions. If it were connected with sex it may very easily have had a pleasant emotional tone. So he deliberately repeats the experience whenever he gets the chance. He makes sure that it is burned in so indelibly that nothing can remove it. Yet we must not overemphasize the very evident and pleasant emotions connected with sex; there are others.

For instance, Johnny does not want to go to school. He can muster a very small stomach ache. He complains of it and is delighted at the attention. The stomach ache promptly assumes serious proportions and he is allowed to stay home. He has learned a great lesson. Stomach aches are wonderful things and should be cultivated. They can also be very easily faked. So Johnny carefully develops the technique of being sick, which strange to say, very soon becomes quite automatic. When he is faced with a disagreeable situation his digestion goes completely to pieces. As he grows older this may take the form of hysterical vomiting and we have a full blown hysteric on our hands. The original situations yielded great pleasure, which sensitized the brain. They were carefully repeated, because of this pleasure. Now we have them so deeply burned in that a cure is hopeless.

There are two points we should note about this case and those following. The original cause may be entirely forgotten. The reaction becomes habitual. This is easily understood. Tumble any one of you into water and you swim—you don't think about it. On a bicycle you simply pedal ahead. Place a pen in your hand and you write. You have long since forgotten, and probably cannot recall, the exact circumstances in which you first learned these activities.

Secondly, this type of individual is really very clever. You may say in a pitying voice that he is crazy, but he might well look on you as being, at least, very foolish. When you have something disagreeable to do, you do it at the cost of great effort, or at least try. But he always sidesteps and does it in such a way that everyone pities him and comes to his rescue. From one point of view you are the one to be termed "crazy." The insane are quite sane, if we choose to look at it that way.



St. Luke's Hospital. From an aquatint by Pugin and Rowlandson in Volume III, "The Microcosm of London," 1810

The action of this pleasure principle was very well shown in the cases of so-called "shell-shock" which occurred in the last war. These were very interesting in their origin. The man in question was caught between two fires. He wanted to save his skin and he also wanted to avoid disgrace. His solution was beautiful in its simplicity. Let's be sick, because a sick man can't fight and no one can blame a sick man for being sick. The brain was already highly sensitized because of the strong emotions involved. Then, let us suppose a shell exploded close by and buried him. When they dug him out his right leg was wrenched and hurt. There flashed through his mind the idea of paralysis of this member, with the comforting thought that now he was out of the war. His intense fear and desire gave the necessary conditions so that, on an examination, sure enough, the leg was paralysed.

These cases were most interesting. A very small throat wound would result in inability to talk—deafness from a slight bruise on the temple or blindness from the flash of a shell. Note that these people were really sick, but also that it was purely a result of emotion—there was really nothing wrong with the eye, or ear or leg. You might refer to them as insane, because in some cases they were very violent, but note that from one point of view they were very, very sane. They were safe back in hospitals, while their comrades were being blown to bits; and to a greater or less degree this was because of deliberate choice on their part.

Similarly we may apply our same general outlook to the pervert, as seen, for example, in the homosexual. Here we have an individual who at an early age has learned to gratify his sex desires along abnormal lines. His perverted activity has been burnt in on an emotional basis which is self-evident. He now acts in accordance with the pleasure principle. The one factor which makes the majority of these cases incurable is the fact that the individual is happy as he is and has no desire to be cured. Unfortunately his pursuit of pleasure all too often ends in disgrace and imprisonment. The same applies to many cases of the criminal and the criminal insane.

But our best examples come from the field of those major insanities where the individual is no longer in touch with reality at all. For example, take a case like the following. We find a man in an asylum who claims to be a great medical genius. He has a grand elixir which will cure every disease known to humanity. As a matter of fact he will talk quite sanely on most points but on this one he is "off" and, moreover, what he has to say about doctors just wouldn't bear repeating in polite company.

WHAT is the explanation? A relatively simple one and quite sane—from his point of view. As a child he derived his great pleasure from the "superiority" complex. He was taught to regard himself as intellectually superior to all other children—and believed it. In reality he had a very average mentality. Through high school and college his record was poor, but his real interest was medicine, so just wait till he got the chance to "show his stuff" in medical school. He admitted he was a real genius as a budding doctor. So he entered a good medical school, lasted one semester and was flunked out.

That was a terrific blow. Either he wasn't so good or the medical school was wrong. His entire background told him he *must* be good. It was the "theme

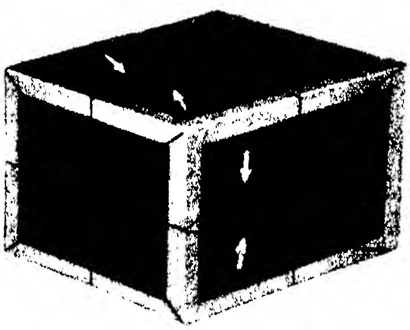
(*Please turn to page 222*)

PINHOLE PHOTOGRAPHY

Pinhole Cameras Not Toys . . . Produce Excellent "Atmospheric" Effects . . . Easy To Make

By FREDERICK W. BREHM

MANY questions have been asked about "pinhole" photography. Some think of it as a child's toy; some look upon it as a distinct novelty. Many advanced amateur photographers consider it seriously and are justified in doing so for pinhole photography has a place in pictorial art. The sketch artist and the painter do not depend upon extreme sharpness of line or drawing to make their pictures attractive but more upon the arrangement of light and shade which, together with the softness of line, gives atmosphere and feeling. It is this effect that can be reproduced through the use of pinhole photography.



Pinhole camera, showing finder lines, the pinhole, and a shutter

The mechanics of the pinhole camera has largely centered around the making of the pinhole but experience has taught me that thin black paper of hard texture is an excellent material through which to pierce the hole.

If it is convenient to remove the lens from the camera you now own then a pinhole attachment can easily be substituted. A black paper cap can be made to slip over the shutter barrel, or a light, tight-fitting piece of cardboard may be placed inside the barrel.

When using either the paper cap or the cardboard fitting, a quarter-inch hole should be made in the center. Over this opening glue the hard black paper through which the pinhole is to be made. A No. 10 needle, 0.020 of an inch in diameter, is used for making the perforation. This hole should be made from the outer surface, the needle being held between the thumb and first finger and carefully forced through with a drilling motion.

If you do not want to disturb the lens of your camera, a cardboard box can be made of proper dimensions to hold either a plate or film holder, a film pack, or a single cut film. You can use ordinary film. When determining the focal length of the box that is to be made, it is best to follow the old rule of measuring the diagonal of the picture area. The diagonal of a 3¼ by 4¼ picture, for example, is approximately 5⁵⁄₁₆ inches; consequently this should be the distance that 3¼ by 4¼ film is placed from the pinhole. Such a box is easy to make but it must be dead black inside and light tight.

Illustrations courtesy Eastman Kodak Company

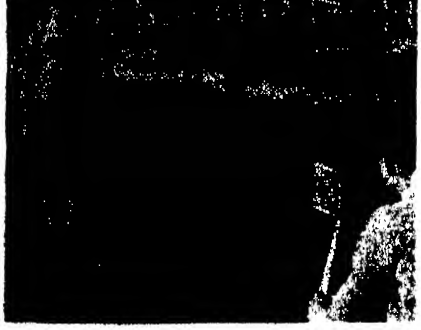
Photographs with a pinhole camera. *Above:* 48-second exposure at 8:30 A. M. in July. *Left:* Silhouette taken at 7 P.M. in July: 32 seconds

A convenient form of box is illustrated, on which finder lines have been drawn. When using a box of this type these lines are used to locate the object within the picture area. Where pinhole attachments are used on manufactured cameras, the regular finder is employed in the usual manner.

The following table gives adequate exposures for ordinary cut film:

Subject	Sun	Sun Under Light Clouds	Dark Clouds
Marine and beach scenes, distant landscapes, mountains, snow scenes	8 sec	16 sec.	32 sec.
Ordinary landscapes showing sky, with principal object in foreground	16 sec.	32 sec.	1 min.
Nearby landscapes showing little or no sky. Nearby subjects in open field, park, or garden	32 sec.	1 min.	2 min.
Shaded nearby scenes, paths in the woods	1 min.	2 min.	4 min.

When using the home-made camera it can be fastened to the tripod with a rubber band. Don't let the camera move when making the exposure.



***Above and Left:* How the finder lines are used to determine horizontal and vertical composition**

PAINTS IN

By PHILIP H. SMITH

Rise of the Synthetics . . . New Research, New Developments . . . Rubber Paints . . . Types for Industry, for Homes . . . An All-Purpose Finish?

Finishes which can be sprayed are of comparatively recent origin and are very profitable

ANYONE who has kept a weather eye cocked on the paint and varnish industry, if only to read its recent advertisements, must be aware that this ancient enterprise is in the throes of transition. Hardly a month passes without bringing to the fore some new product and, if we believe all we read, we could assume that the millennium is not far off when there will be a single paint good for all ailing surfaces and which, when placed on the old homestead, can be handed down from father to son.

Such a happy interpretation is inaccurate. The goal of paint chemists has been to produce better finishes, to reduce the time required for application and drying, and to lower costs. To this end they have modified existing practices and have contributed new materials which supplement rather than replace the older ones. Far from creating an all-purpose, everlasting finish, they have spawned innumerable products, each with its own particular uses. And through their research they have quickened the use of synthetic materials.

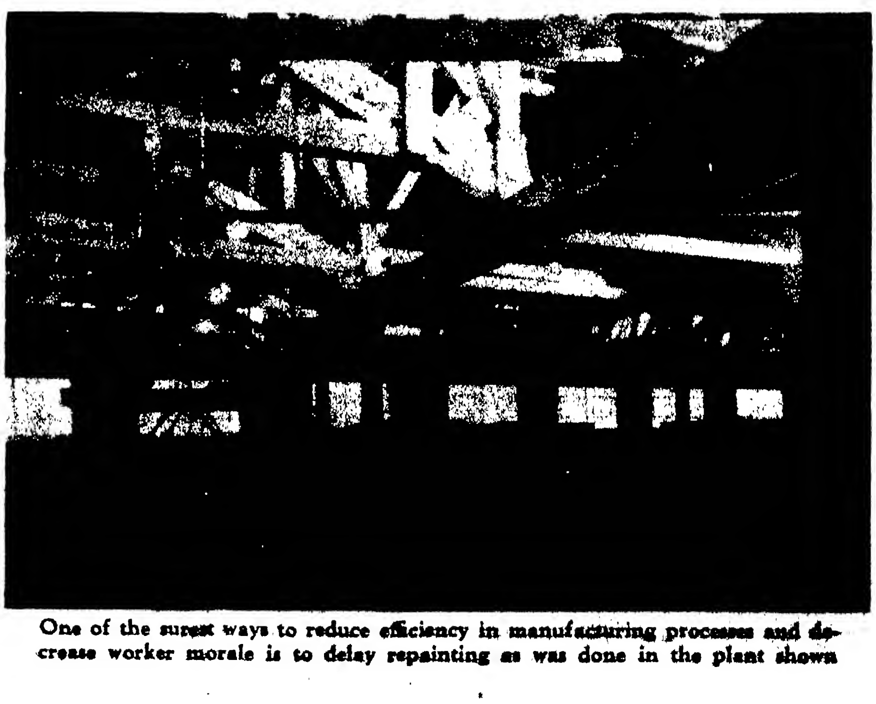
The rise of the synthetics, and notably the resins, is the outstanding feature of paint chemistry and far and away the most interesting, for the synthetics tie in closely with other paint developments and in them lie the possibilities for higher attainments.

The synthetic resins, as with most of the newer discoveries, had their inception many years ago. Ester gum, the first one, was discovered 40 years ago by chemically uniting rosin and glycerine. It was shortly put to use in varnish making because it was superior to raw or limed rosin, and then little more happened in this direction until the advent of nitro-cellulose lacquers, also synthetic.

Everybody knows what a whirl the nitro-cellulose lacquers created. Paint chemists laid the foundation for them but the driving force which carried them through to commercial success was supplied by the automobile industry where it was recognized that a quick-drying, durable lacquer would save fortunes in the painting of mass-produced motor cars. It is safe to assert that this development was as revolutionary as any which has struck the paint industry. It almost squeezed the linseed oil, fossil resin varnish makers to the wall. It promptly reduced certain painting operations from multiple, hand-applied to single spray jobs and it demonstrated that time and cost factors in lacquer and varnish work could be modified beyond the manufacturers' wildest dreams.

Of course, this didn't happen overnight. It took years to develop satisfactory undercoats, suitable solvents and workable spray guns to make the new lacquers wholly feasible. But that work, particularly with solvents, paved the way for what was to come. Shortly after nitro-cellulose got under way, the phenolic resins were introduced. It had been found that they could be combined chemically with rosin to maintain a sufficient solubility for varnish work. This brought the so-called "4-hour" varnishes and enamels into being and with them the first general use of synthetic resins other than ester gum.

There are literally hundreds of synthetic resins, each having properties which differ slightly from the others. For commercial exploitation close to a hundred are marketed, representing the types which have the best combination of qualities. There is no longer one type of phenolic, but many types, and there are paracoumarone, indene, and alkyd resins. Just why there should be such a variety can be told best by classifying and describing their use, otherwise the reader's confusion may equal that of the paint manufacturer when he tries



One of the surest ways to reduce efficiency in manufacturing processes and decrease worker morale is to delay repainting as was done in the plant shown

TRANSITION

IN this, the fifth of our important new series of industrial articles by Mr. Smith, there is a "between-the-lines" story for the home-owner. Paint is going to play a vital part in the campaign for better housing which is now being promoted aggressively by the Government, by institutions concerned with health and sanitation, and by several large corporations. This article does not tell the home owner specifically what paint to use. It does, however, tell him what he may expect in paint quality and type.

To answer particular questions on painting problems, there are available the following bulletins which will be forwarded—one or more, as desired—upon receipt of a 3-cent stamp for each bulletin to cover mailing costs:

1. Making the House a Home
2. The New Decorator
3. The Home Decorator
4. Using Paint as Light

In industry the spray gun has worked hand in hand with the faster mass-production methods

to decide which one of them to choose.

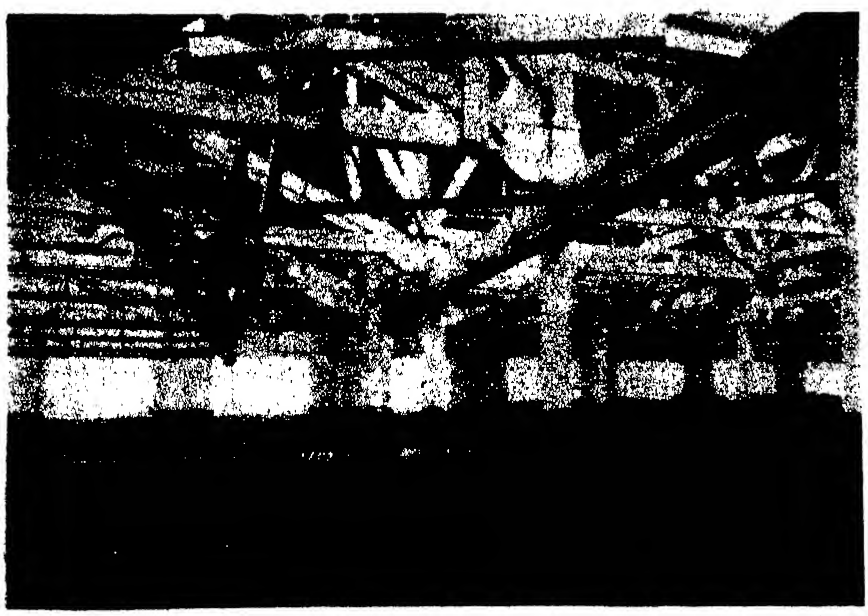
Of the four main groups of phenolics, the first are the rosin modified, or compounds of phenol and aldehydes dispersed in esterified rosin. These resins figure prominently in the "4-hour" varnishes and enamels where quick drying and weather resistance are sought. The second group covers the formaldehyde condensation types, modified with fatty oils. Their use is largely in water-resistant undercoats and baking enamels, and sometimes in lacquers.

Two types of straight phenols make up the third and fourth groups. One is heat-reactive, the phenol compounds being rendered oil soluble and suitable for varnish with dispersion in ester gum or oil. They are used in baking finishes where drying is accomplished by heat polymerization (condensation of like molecules) rather than by oxidation alone. The other type, in the fourth group, is permanently fusible. It is used when quick drying and resistance to water, alkalies, and abrasion are desired.

The paracoumarone and indene resins are neutral, with marked resistance to alkalies, dilute acids, and brine, and their greatest use is in aluminum vehicles and bronzing liquids, coatings for pipes and concrete paints.

We can end this classification with the alkyd resins, made from polybasic acids or anhydrides. Here there are three groups generally recognized. In the first, the resin is modified with natural resin acids and becomes a good ingredient for nitro-cellulose lacquers and for sealers. A second type is modified with non-drying oils and fatty acids for use in lacquers, while the third and last type is modified with drying oils to find some application in practically every type of finish. One distinct advantage of the alkyds is their aid in retention of tint values and high gloss.

The reason these resins figure so prominently in connection with nitro-cellulose lacquers, stems from a desire to overcome inherent weaknesses in the latter. It has been patent, for example, that a lacquer which contained a high percentage of solvent and a correspondingly small amount of solid left something to be desired, since a single application meant a thin coat and a substantial loss in solvent evaporation. Synthetic resins came into use when they could contribute a higher solid content, and then, having stimulated creation of many solvents for themselves, it quite naturally followed that they should be used to make their own type lacquers which tended to replace the older one.



Under approximately the same lighting conditions as in the picture at left, the new paint job here pays dividends and promotes safety and worker contentment

RECENTLY a new process was announced which may bring about a recrudescence of the nitro-cellulose lacquers, though commercial application has not yet been fully worked out. It calls for removal of most of the water-miscible solvents, using a mulsifying agent compatible with the film and, finally, emulsification of the lacquer in water by mechanical means. The advantages claimed are a much higher solid content of sprayable lacquer, better brushing qualities, and a reduction in the loss from solvent evaporation, since the vehicle is largely water. Considering that ordinary solvents are inflammable, there would be a reduction in fire hazard.

We have portrayed synthetic resins as cutting the widest swath in the industry and this is plainly reflected in the downward curve traced by the importations of natural resins. But there is still another important synthetic to consider. Rubber is being brought forward as a paint base and there are many well-informed technical men who believe that delving in rubber will yield the largest nuggets. Contrary to what might be thought, rubber is being introduced because of its high resistance to acids and alkalies and not for any supposed quality of flexibility. The mental image of a coat of rubber base paint being stretched over a surface is wholly erroneous.

TWO types of rubber bases have reached the commercial stage. One is principally a hydrocarbon derived from crepe rubber; the other a chlorinated form. Both feature resistance to acids, alkalies, and moisture, and both can be formulated to have excellent properties of adhesion. This singles them out immediately for industrial use. The hydrocarbon is pigmented with other ingredients to form a highly plastic material for dispersion in the proper solvents. Variations in formulation make finishes suitable as primers, for use on concrete, or for baking enamels and interior paints. The chlorinated rubber base can be used unpigmented for clear films for indoor purposes, or it can be pigmented with a wide range of ordinary pigments for outdoor exposure and specialty paints, and it is compatible in films with a great number of oils, gums, and resins.

Before we try to evaluate the place of synthetic materials we must consider their use. It is chiefly industrial. Synthetics do find application in lacquers and varnishes, but scarcely at all for interior and exterior walls where approximately 85 percent of all paintable surfaces are said to be. Here synthetics have hardly made a dent—progress in this field is of a different order.

Discussion of household paints demands an abrupt shift from synthetics to natural products—to a discussion of new products, development of new processes, and modification of old ones. Both pigments and vehicles have been affected.

Notable in the rise of natural products has been soy-bean oil. This oil began to have commercial significance after the turn of the century, and in 1933 the paint industry consumed about 8,500,000 pounds of it. It does not have the drying qualities of linseed oil, but it can be used in amounts of 10 to 15 percent of the vehicle in conjunction with linseed and will provide a more elastic film. Furthermore it mitigates the after-yellowing of white paint and enamel. It is now used widely for grinding pastes because it checks skinning-over and fortifies the retention of original tints of the pigment.

Another important use of the spray gun

Fish oil has also grown in favor. Improvements have been made in processing so that today's product has much less odor and its refined types follow closely upon those of linseed. Here again, drying qualities cannot approach those of linseed oil, so only partial replacement can be made. Both soy-bean and fish oils compete with linseed oil more on a price than a quality basis at the present time, but that does not imply that a wider use for them may not be justified as further gains are made in processing and the technique of handling them.

Among the advances in pigments can be mentioned a multiplication of zinc oxide types to obtain special properties such as improved color, brightness, gloss, and leveling. But outstanding in pigment development is the rise of aluminum and the titaniums—dioxide, barium, and calcium base.

Aluminum has received a great deal of attention because it has been brought forward aggressively and has strong eye appeal, but it also has much merit. The aluminum pigments have established themselves firmly in the field of wood primers because of their capacity to prevent "bleeding." They resist acid fumes and the effects of the sun very well, but they are not an all-purpose pigment.

Titanium oxide and titanium barium base were introduced commercially 15 years ago, followed shortly by titanium calcium base. They made a slow but steady gain until recently, then moved rapidly toward the center of the stage when lowered prices made them competitively attractive. Titanium oxide goes into nitrocellulose lacquers where low pigmentation is desired, into oleo resinous enamels and into synthetic resin paints of the glycerine phthalic anhydride or alkyd type. Titanium barium has a much wider use. Its quality of opacity carries it into all types of house paints while its freedom from reactivity has made it a favorite with synthetic resins. Titanium calcium, the newest member of the family, goes into interior paints of the flat wall, gloss, and mill white types, and into primers and sealers. The hiding power of all the titaniums is higher than most opaque white pigments and they are very stable and inert chemically.

THE simultaneous rise of synthetic products with preponderant industrial use and natural products with their broad coverage of household paints presents a picture of currents and cross-currents, and this picture is a valid one. But it is the main flow that we are seeking here and this will become apparent when we touch upon some of the industry's peculiarities.

The making of paints and varnishes has always been a high art and only now is it headed toward becoming a science. Chemists working largely outside the industry, concerned primarily with the utilization of specific materials, have introduced their findings for coördination with existing practice. Thus art and science have been mingled with varied effect. Only in recent years has there been a concerted attempt to seek scientific explanation of everyday procedure in commercial paint and varnish making—to place what has been an art upon a sound basis. This lag makes for slow adoption of the latest fruits of research.

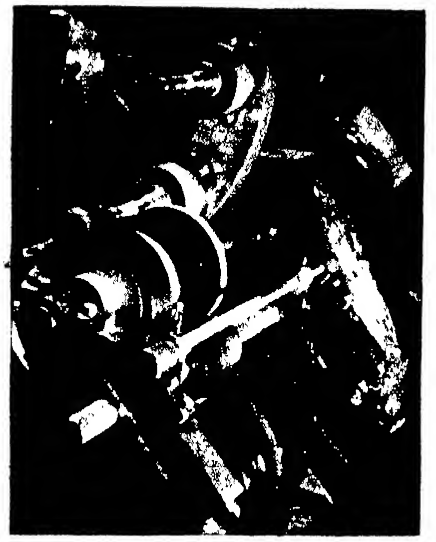
By way of illustration, take the introduction of synthetic resins. They do not stand alone in revolutionary manner, but must be used in conjunction

with rosin, oils, or fatty acids. They go into the varnish kettle—which has always been handled as an art—though their most productive use would presuppose a scientific understanding of the chemistry of the varnish kettle, something which has not yet been worked out for the benefit of the industry as a whole. Working back to fundamentals may conceivably bring forward older materials now appearing to be on the way out, as well as establish the merits of the new. Understanding of synthetic resin reactions, for example, may reveal unknowns relating to the natural resins.

Here current and cross-currents are unmistakable. But ultimately there will be a unified flow involving a scientific grasp of all the many variables now covered by the art. It is essential that this control be established before a maximum use can be made of recent discoveries (or former arts). This will be done. It is being done.

ANY industry in transition suffers a lag in the translation of scientific findings to commercial ends and the paint industry is no exception. Tradition and a solid background even add to the delay, but not forever. There is great impetus for change coming from the purveyors of raw materials who have products for introduction. In time they pass experimentation in the hands of the manufacturer, leading to use if merit warrants. At the moment the speed of introduction is terrific, especially with resins, and the adoption is somewhat retarded by the difficulty of selection.

Let us not overlook the fact that paint is always a compromise. Every paint calls for a different grouping of qualities and there are limits to the speed with which the most satisfactory groupings can be made. Every new pigment, every new vehicle, carries with it its own special combination of qualities which may or may not be altered when grouped with other pigments or vehicles. And there are literally hundreds of new materials. Each enters the arena to



Machine which paints tiny cans for condensed or "minute" coffee. The arrows point to two of the cans

stand or fall on its own merit—to find its own level—and so far the newcomers have been supplementing rather than replacing the older forms. They have not banished the compromise feature but merely lessened it by contributing a broader grouping of qualities. Their real importance lies in the fact that they have expanded the field for experimentation enormously and have thereby multiplied the possibilities for the future.

If anyone looks to the future to provide an all-purpose finish, that future is still far away, perhaps tied to the discovery of an all-purpose resin. At the moment the trend is wholly in the opposite direction—toward specialization. Paint is no longer just paint, where quality of ingredients is indicative of all-around quality of service. The finishes of today must withstand a host of conditions which did not prevail 100 or even 50 years ago. Some must fight corrosion, others must resist gases, and even weather resistance implies different kinds of weathering. A Pullman car, for example, hurtling along with dust abrading its surfaces cannot be protected adequately with roof paint.

Chemists may very likely create far more enduring interior and exterior house paints. If they succeed, it will probably be through further experimentation with synthetics—rubber, resins, or something yet unknown. Synthetic resins have already established their superiority for the surfacing of electric refrigerators, automobiles, electrical insulation, and for production finishes of many types. Why should they not conquer the field of house paints? That they have not yet done so is due partly to preoccupation with replacement of natural resins and in a measure to disappointment with the outcome of early attempts at utilization.

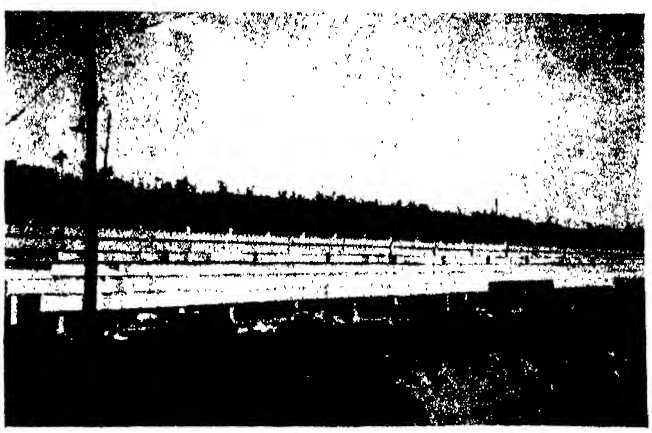
Given more suitable resins, better combinations, and improved technique, this type of synthetic may yet figure heavily where the home owner will benefit directly, unless the rubber base paints steal a march on it. Chlorinated rubber, for example, gives great promise for exterior finishes. It can be used with most pigments; it has good qualities of adhesion; and flexibility can be imparted to it by ordinary drying oils.

NO paint manufacturer is in a position to prophesy the future of synthetics as opposed to natural materials because he is confronted with factors beyond his immediate control. Whichever proves best, price is a primary consideration, for no matter how good a paint can be made, it must be priced within the consumer's reach and that reach isn't very far. Chemists must succeed in reducing costs still further if there is to be wide acceptance.

Nevertheless, the paint and varnish industry is definitely on its way to bettering products and if it has not yet created an all-purpose paint, there is no loss. When the consumer needs paint for specific purposes today he can come much closer to having his requirements met, for that is the aim of paint chemistry and that goal is being approached relentlessly.

Illustrations Courtesy American Paint and Varnish Manufacturers Association, New Jersey Zinc Company, and The Sherwin-Williams Company.

Strong light, water sprays, low and high temperatures—all kinds of "weather" are used to test paints in this tank



An outdoor test of surface finishes. Small panels, each with one kind of paint, are exposed to outdoor weather

Clouds below this TWA airliner indicate that a storm is probably raging in the lower air

Fly High for Comfort

By REGINALD M. CLEVELAND

THE true stratosphere plane is not yet. Nevertheless, airline operators are looking to higher and higher levels and actually sending their big transports with supercharged motors and controllable pitch propellers into altitudes of 12,000 to 20,000 feet for regular flying. Only a year or two ago these strata would have been considered no place for a passenger airplane except when necessary to hurdle a mountain range. They are doing this for two reasons: The first is economy and regularity of operation; the second, comfort for the passengers.

On the first count, it is well known that at about 18,000 feet one is normally above the cloud area and has perfect visibility. Through the rapidly developing science of air mass analysis or "polar front" weather predicting, definite strata of favoring winds can be selected with surprising accuracy, especially at high levels. Furthermore, cruising speeds with modern supercharged engines and with adjustable propellers can be maintained around 200 miles an hour in thin air, using only about 75 percent power, although the throttles may actually be wide open.

The newest propeller development, the Hamilton automatic "constant speed" propeller, is destined to aid materially in such operation. It maintains any chosen engine revolution by automatically changing pitch of the blades through the action of a simple governor controlling oil pressure.

It has been determined that on a journey of 600 miles with a specific 200-mile-an-hour airplane equipped with modern engines and propellers, 26 minutes can be saved by climbing at once to 13,400 feet and then cruising at this level for most of the journey before beginning the landing glide, as compared with flying the same distance with the same airplane at or near sea level.

REGULAR transport flight over long distances at altitudes from 15,000 feet upward, however, will inevitably mean the use of fully sealed cabins supplied automatically with oxygen to compensate for the rarity of the atmosphere. Oxygen in flasks is already supplied when such journeys are in contemplation. It has been used regularly on Pan-American Airways over the Andes for a number of years. It was used by a number of passengers on spectacular transcontinental flights on TWA and on Eastern Air Lines which Captain E. V. Riokenbacker commanded. But this is not sealed cabin operation.

It is but a step, however, from forced and soundproofed ventilation, already a feature of modern transport ships, to the sealed cabin with controlled oxygen supply. Such equipment would appear to be a necessity in the nature of things if the high levels are to be continuously used, since human reaction to altitude is a matter of heart, lungs, and nerves. Disturbing or even tragic incidents might well occur which could readily be prevented if the sea-level oxygen content of the cabin were maintained no matter how thin the air which the plane was cleaving.

The whole question of passenger comfort is one which the airlines are finding of growing importance. Creature comforts in the main have been well provided. Notable advances in soundproofing and in the elimination of vibration mark the most recent types of airliners. Temperature control is already satisfactory.

Although with the exception of the giant liners of Imperial Airways and the newest Dutch Fokkers, the same cannot be said of existing airplanes in Europe. The new transport types, especially those of France, which will soon be in the air, are much on a par with our better machines in these respects. Indeed, these planes have taken a whole handful of leaves out of the American book of practice, both aerodynamically and in what might be called the structural comfort features.

Remaining problems relate rather to the method of operation and the actual flying of the planes which reach very high cruising speeds. They apply to flying on one side of the Atlantic as much as on the other.

While a high-speed airplane is enabled by its very swiftness to avoid many storms and turbulent areas, it is also true that when it does get into rough air, the impacts of gusts and bumps are much more severely felt than at lower speeds. The plane structure may be of such strength as to be able safely to withstand the stresses involved in these impacts; it may be able, with complete security, to plough through the storm and thermal currents over broken terrain, mountains, quickly alternating land and water, and the like. But the passengers are due for a very unpleasant ride under these conditions.

For this reason, many pilots throttle back when they get into rough air. But many do not, and the plane load of passengers which has taken a thoroughgoing beating does not make the best kind of propagandists. Airlines in this country are beginning to realize forcibly, however, that having sold successfully the idea of speed, they must now give increased attention to the idea of a smooth ride, comparable in all its conditions of comfort to that upon the glistening rails, which is afforded by a first class air-conditioned train.

Winds aloft are, as has been said, in strata. The air may be very bumpy and rough at 2500 feet and very smooth and agreeable at 6000 or 8000 or 10,000. In consequence, the wise airline operator is instructing his pilots not merely to seek the level of the most favorable tail winds, but to seek also the level at which his plane load of passengers may obtain the smoothest ride.

But the comfortable flying of a plane is not concerned only with the matter of seeking the least turbulent air levels. It is a matter also of the whole method of take-off, climb, descent, and landing. Unfortunately there are still on the airlines a few pilots of the "hero" school. They may be excellent fliers, most of them are; they may even be very safe and technically correct fliers, fully conversant with all the details of their craft and skilled in getting the most out of them. At the same time, they may be the worst of advertisers from the point of view of increasing patronage on their particular airline.

Approaching the Stratosphere . . . For Economy and Regularity of Operation . . . More Speed With Less Power . . . Avoiding the Bumps

It does not sell air transport, for example, on a flight of, say, 250 miles, to climb a fully loaded plane as steeply as possible to a level of, say, 4000 feet where there is an excellent tail wind but bumps like a roller coaster, hold it there irrespective of the gusts and buffeting till the plane is practically over the boundary of the airport of destination, and then lose nearly all the altitude in a couple of wide swooping circles, so that the eardrums and sinuses of every passenger feel as if they were about to burst from the change of pressure.

ONE of the lines which flies fast and high between Pittsburgh and Newark has instructed its pilots to begin to lose altitude flying eastward about at Trenton. The result is that the big planes coast so gently down hill that one hardly realizes that he has just come down 6000, 7000, or 8000 feet in 40 miles. A comfortable maximum descent is 450 feet a minute. It is all just a matter of operating technique, but it is a matter that a progressive line seeking to build up passenger revenue from full plane loads cannot afford to neglect.

Passenger reaction to the kind of a ride he has enjoyed is more or less alike all over the world. A leading French authority whose business requires him to travel frequently between Paris and London was discussing recently the cross Channel air services. There are now three such services on frequent schedules; two are British and one French. One of the British lines is considerably the cheapest of the three. The French line is measurably the fastest of the three, but the vast bulk of the traffic, this experienced traveler found, took the other British service, that of Imperial Airways, because it was the most comfortable. Its huge, roomy planes, fitted like a luxurious club lounge, and offering every physical nicety of first class travel, were also operated with an eye to smooth riding, partly due, of course, to their relatively low cruising speeds. He and the bulk of other travelers who have taken to the air rather than submit themselves to the stormy passage of the Channel, found it well worth while to pay a modest premium and to sacrifice perhaps 20 minutes of time just in order to be comfortable.

Much remains to be learned, of course, in the realm of the relation of weather to flight from the point of view of smoothness. The development of air mass analysis weather forecasting holds out immense promise of much more definite and accurate long-range prediction. It is sure to play an important rôle in the economics of air transport, and there are those who believe that 10 or 15 additional miles an hour average cruising speed, without increase in horsepower or design modification, may be its gift to air travel. It is quite possible that it can do much, also, to iron out the bumps for the traveler.

Modern air transportation. A United Air Lines plane flying high

A view taken from the east bank of the Columbia River at the site of Grand Coulee Dam. Gravel washing equipment is in the foreground; across the river are the contractor's camp and Government road grades

ON A NATURAL DAMSITE

At Grand Coulee . . . Original Dam Was Pushed Up By Nature . . . Man-Made Dam Will Be In Two Units, For The Development Of Hydro-Electric Power

By GRACE KIRKPATRICK

UNCLE SAM now has underway one of his greatest construction projects, on the Columbia River in central Washington, 92 miles west of Spokane—the Grand Coulee Dam.

Spectacular and colossal as this structure will be—for it is planned as one of the world's largest—still there was a greater dam at the same spot centuries ago. This original dam, however, was not built. It was pushed up by nature, and because of it the Bureau of Reclamation now finds ready at hand a huge reservoir in which will be impounded the waters of the Columbia which will be distributed to millions of thirsty acres.

The story of this dam of ages gone, is the story of the Coulee. It was formed by a prehistoric glacier descending from the north and carrying with it thousands of tons of earth, sand, gravel and rocks. The glacier reached the bed of the Columbia, a mightier river by far than it is today, and dammed it. The torrents of water broke through the high cliffs that border the Columbia, in an effort to find a course, and flowed down what today is called the Grand Coulee or "grand valley." As the glacier retreated to the north, the river returned to its original course and left the Coulee a place of geological wonders, a place of giant black rock and vast silences. It is a valley with walls at some points a thousand feet high, showing in their stratification seven distinct lava flows that descended on the region even before the time of the ancient glacier.

IT is the upper 20 miles of this Grand Coulee, rockbound as it is, which will be closed with dams at both ends to form the reservoir when the Grand Coulee dam is finished. This site was chosen because this old reservoir was conveniently at hand, and because the surveying and testing which were carried on for years by the United States Army engineers, the engineers of the Bureau of Reclamation, and of the state of Washington, revealed a bedrock of solid granite at this point on the Columbia River where the Coulee joins it.

To understand how great this dam will be, it is necessary to know something of the Columbia River which, in the United States, is second in size only to the Mississippi. Because its source is high in a region of melting snows in the mountains of western Canada and Montana, its discharge is more continuous throughout the entire year than that of any other river of the land and in 1934 it carried more water than all the streams of the arid regions of the west and middle west combined. At the site of the Grand Coulee dam, it has a minimum flow of 17,500 second feet and a run-off five times as great as that of the Colorado River at Boulder Dam.

This great surge of water rushes on, sweeping across the state of Washington and forming for many miles the border between Washington and Oregon, unused, to the sea. On the plateaus

above its canyon-like banks are millions of arid acres known as the Columbia Basin project. Dr. Elwood Mead, the United States Commissioner of Reclamation, has called the Columbia Basin "one of the most fertile bodies of irrigable land in this or any other country" and there are 1,200,060 acres of it which can be irrigated from the waters of the Columbia when the Grand Coulee Dam is complete.

The dam is to be built in two units—a high dam and a low dam. The low dam is now underway, the Government having awarded the contract to a group of New York, Iowa, and California contractors who have combined as the Mason-Walsh-Atkinson-Kier Company.

THE low dam is exclusively a power development, while the high dam will be a combination power, irrigation, flood control, storage, and navigation development. It is the key dam on the Columbia River, which river holds the greatest hydro-electric possibilities of any river in the United States. It will raise the waters of the Columbia so that they can be pumped into the reservoir of the Grand Coulee, thence to flow over the parched acres of the Columbia Basin project. It will, in addition, back up the waters of the river to create the longest artificial lake in the world which will extend 151 miles to the Canadian border and beyond.

The Grand Coulee Dam will be the largest power development possible in North America. The high dam, 500 feet above bedrock, and 4100 feet long, or nearly four times the length of Boulder Dam, will develop three times the power of Muscle Shoals, 50 percent more power than Boulder Dam, or as much as the total installed capacity of Niagara.

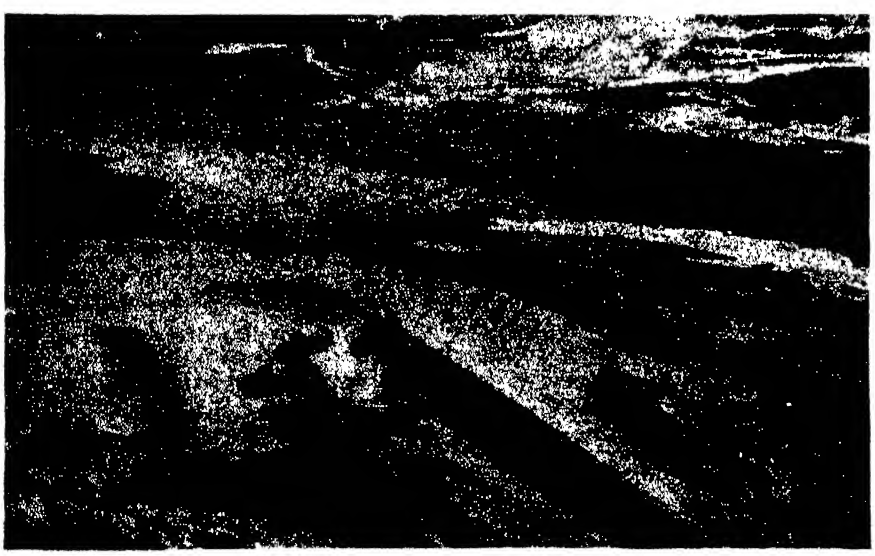
Until about a year ago, the great river rolled on unheeded. The Coulee was a place of weird shadows and undisturbed sagebrush plains. Then President Roosevelt caused the Public Works Administration to allocate 63,000,000 dollars to build the first unit, or low dam. At once engineers started their surveys and plans. Test pit diggers and diamond drill men moved in by the score to make their observations, with the result that it has been determined that under the swift flow of the Columbia, under the towering hills which are powdery fine with volcanic ash and sand, and under the clay beds of the river banks, there is solid granite. As R. F. Walters, chief engineer of the reclamation service states, there is provided in this granite a perfect and a safe foundation for the colossal dam which, as designed, will be a concrete straight-gravity dam. The first development, now under way, includes the main portion of excavation for the high dam, the construction of a concrete straight-gravity dam about 200 feet below the elevation planned for the high dam, and a permanent downstream coffer-dam and a power plant. The permanent coffer-dam located below the toe of the present development will form the toe of the high dam

Steamboat Rock in the Grand Coulee. When the dam is finished, many geological formations such as this will be flooded by water

The dam now being built will require 4,000,000 barrels of cement, 23,000 tons of steel for coffer-dams, 67,000,000 pounds of steel for reinforcing, and 50,000,000 board feet of lumber.

The low dam will measure 300 feet in height, with a length of 3400 feet at the crest. It will have a total capacity of 700,000 horsepower of electrical energy with 147,000 horsepower to be installed at the start. It will require about four and one-half years to complete.

The cost of the ultimate development, or high dam, will be 179,000,000 dollars. This dam will measure 500 feet above bed rock, with a length of 4100 feet at the crest. It will have a capacity of 2,646,000 installed horsepower and require about six years to build. The spillway in the center of the high dam will be 1800 feet long and 325 feet high, and water flowing over it will present one of the world's most remarkable water spectacles.

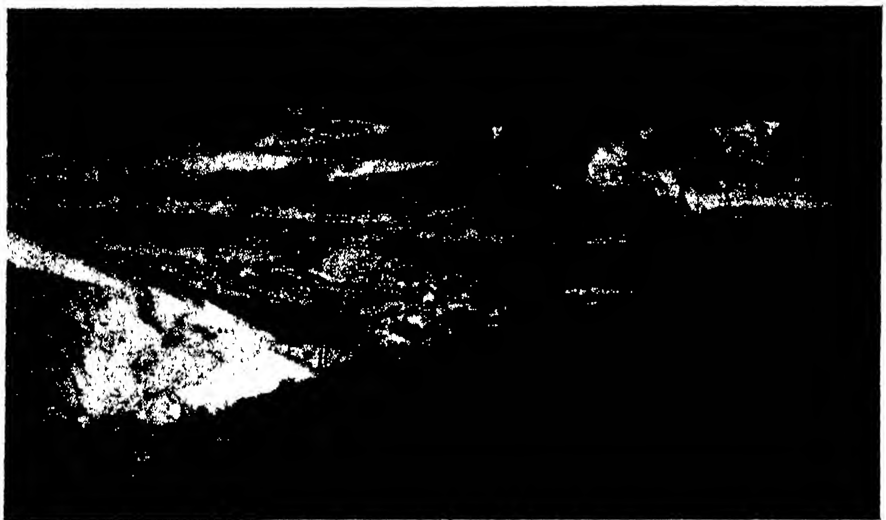


A spoil bank piled up by preliminary excavations at the site of Grand Coulee Dam. This bank forced up the islands visible at the right, and may have to be removed as work progresses and further excavations are made to reach bed rock

UNITED STATES Army Engineers estimate completion of the Columbia Basin project will add 1,403,000 people to the population of the Pacific Northwest, and based upon the present per capita wealth of this region, the increased taxable wealth will amount to 3,000,000,000 dollars.

In any such mammoth project there are of course problems of engineering, solutions of which seem as miracles to the layman, but in starting the Grand Coulee there were obstacles peculiar to it which had to be worked out at once.

The damsite was some 20-odd miles from a railroad and almost as many from a highway. True, there was a scenic road along the floor of the Coulee and winding down the sheer cliffs to the Columbia, but it was in no sense a heavy duty highway fit to bear tractors and big machines. In fact, it gave way utterly last winter during the preliminary excavation. With a road down the Coulee already complete, the Government is now at work constructing



Looking down on the construction work for the Government railroad and highway at the damsite. Excavation at right is for the east end of the big dam

an extension of it from the end of the Coulee down the cliffs to the site of the new Government town and the damsite. In some places this means blasting through solid granite; in others it calls for the careful sloping of easily disturbed hills of fine powdery sand.

A railroad is also rapidly stretching out the 20 miles between the dark Coulee walls and is likewise being constructed down the precipitous cliffs by means of curves and switchbacks.

IN addition, the government found itself compelled to build a bridge in order to build a dam. Since the white man came to the west the Columbia has been crossed at this point by means of a crude ferry. Adequate for Indians from the nearby reservation and for the ranchers and sheepherders bringing their flocks down from the hills, this ferry would not do for railroad cars, for cement, for steel and heavy machinery such as will be needed for a gigantic dam. A steel cantilever bridge is therefore being built to take its place forever.

The actual building of the dam also entails two major problems, according to F. A. Banks, engineer of the United States Reclamation Bureau and in charge of construction at the Grand Coulee.

"The immense amount of excavation necessary, the great force of the Columbia River, and the huge amount of water it carries are three problems which confront us," Mr. Banks said.

Because of the large amount of overburden, and because the dam will stretch out to such great length, the excavating calls for the removal of 15,000,000 cubic yards of material for the low dam and an added million for the high dam, whereas the entire amount of excavation at Boulder Dam totals 6,000,000 cubic yards. The figure given for Boulder Dam includes the excavation for diversion tunnels but there are to be no diversion tunnels at the Grand Coulee.

The reason for this last brings us to the second problem, the handling of the great force and flow of the Columbia River while the dam is being built. Engineers have decided that it would be impossible and impractical to dig diversion tunnels to carry the mighty stream in another course while the dam and its foundations were being put in place. To turn the great stream entirely from its deep gorge was much too gigantic a task.

Instead, the plan is to build circular coffer-dams on both sides of the river where the dam will cross, thus diverting the waters to the extent of temporarily forcing them through a narrowed channel in the center of the river. Inside these circular coffer-dams two sections of the big dam will be built, one extending toward the center channel from each shore. In these two sections of the dam, openings or tunnels will be left. When they are complete, the two circular coffer-dams will be removed and others will be built to divert the water from the center channel and force it to flow through the openings or tunnels in the dam. With this accomplished, the center section of the dam will be built to join the two end sections reaching out from the two shores.

A STUPENDOUS undertaking it sounds, and is. A fascinating task to watch even in the early stages now in progress, for the silence of the Coulee is utterly shattered. Huge bulldozers and trucks are heard constantly. Blasting throws shattering echoes through the hills. Hundreds of houses, warehouses, office buildings are rising where only sagebrush grew for centuries. Pile drivers and gravel washers bang and clatter. Grand Coulee Dam is under way.

●

A vehicular and railroad bridge across the Mississippi at New Orleans has long been needed. Such a bridge is now under construction. The pertinent details of it, as well as the economic significance of its location will be told in an article soon to appear in these pages.—The Editor.

A truck and steam shovel moving huge granite blocks to clear the way for the railroad grade to the damsite

Huge hills of volcanic ash and sand present another problem. 16,000,000 cubic yards of material will be moved

CORK IN FIRE BRICKS

Diatomaceous Earth and Clay Bricks, Molded With Water, Made More Porous By the Use of Cork

By T. E. WOOD

FUEL, heat control, and refractories are the three essentials of the modern furnace. In many cases, gas is considered to be the best and most economical fuel. Heat controls have reached a high point of development. Recently, progress in the refractory phase of this trio has taken a spurt forward, thereby materially increasing furnace efficiency. Refractory insulating brick, now available, will produce savings in fuel and heating time and facilitate heat control by reducing heat losses through conduction and radiation some 60 to 70 percent. These economies result not only from the low thermal conductivity of the semi-refractory materials but also from their light weight which accounts for a low heat capacity. One of the leaders in this field of development is the Armstrong Cork and Insulation Company.

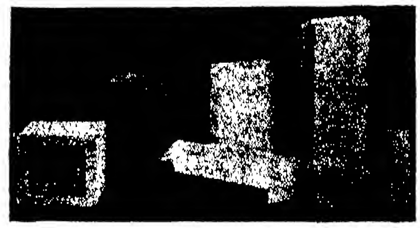
The most important ingredient used in the manufacture of insulating brick is diatomaceous earth, a light cellular mineral that has a very low heat conductivity. Pulverized and mixed with ground cork and clay, this earth is molded to shape and fired in a kiln. The cork is burned out, leaving additional air cells that help to increase the insulating qualities of the brick or molded shape.

Various cutting wheels are used here for cutting special insulating shapes

Insulating brick are made at Armstrong's Beaver Falls plant by the soft mud process which consists of mixing the materials with water to obtain the right plasticity, filling multi-cavity molds with this mixture, and subjecting it to high pressure in giant presses. The molds are moved out of the presses and mechanically upset so that the brick and shapes fall on traveling belt conveyors which take them to the dryers. Operators remove the brick from the conveyors and pile them on the drying room shelves where they are dried with heat from steam coils. Large special shapes are molded by hand. Firing is accomplished in one of two gas-fired kilns, each 300 feet long. Cars are pushed through the kilns by mechanical pushers. Heat is supplied to each kiln by eight gas burners, four on each side, and as there is no muffle, combustion takes place directly within the kiln.

Press room with mixing machinery and giant press for brick making

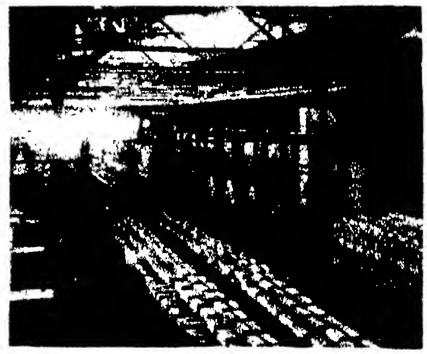
Nozzle mixing burners are employed, air being supplied by a motor-driven blower through one pipe and gas through another, both of which terminate in the burner. Orifices are set in a ratio of 10 to 1 and the gas and air pressures are always maintained at the same pressure by a zero governor in the gas line and a by-pass from the air line.



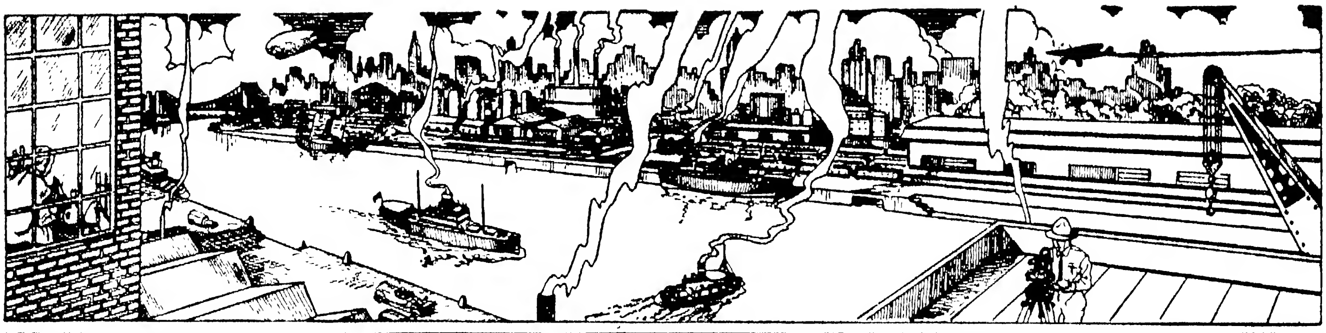
A few refractory shapes which can be made by the ground-cork process

Fluctuations in the air pressure by turndown or otherwise are instantly reproduced in the gas line and this system permits a single valve control; in this case, a blast gate valve in the air line.

MACHINING to size is an important phase of production in this plant and the tolerance is held to 0.01 inches. When the brick are fired they acquire a slight bow and this is corrected in the first machining by grinding with emery and Carborundum wheels. The other faces are then finished to size. Another important activity of the company, in connection with its customer service, is the manufacture and stocking of a large number of special sizes and shapes. In making up many of these a standard size 24 by 12 by $4\frac{1}{2}$ inches is produced and these are cut to specifications with circular and band saws and disk grinders. Standard sizes for skewbacks, circular crowns, and so forth, are made in this way. Adjustable saw tables are provided for a wide range of tapers and heights. Shapes for suspension are drilled for pins and are used for placing a flat arch where furnace conditions permit.



Kiln room showing two gas-fired tunnel kilns for insulating bricks



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

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Probing Into Brain Processes

CHANGES in electricity in the brain promise to allow physicians to probe painlessly into the brain processes of healthy and sick persons in much the same way that heart action is now studied by graphic records of the electric currents emanating from heart muscle.

Pieces of metal fastened next to the skin

Science Service Photograph
Science probes into the brain processes with this instrument set-up

on the patient's head pick up the brain currents. The patient feels neither pain nor other unpleasant sensation from the strange-looking headgear shown in the accompanying illustration. The instrument, resembling somewhat a radio set, is a vacuum tube amplifying system. This magnifies the brain waves so that the current can operate an oscillograph which writes in light on a film a wavy line corresponding to the fluctuations of the electricity in the brain.

This particular piece of apparatus was used by Drs. H. H. Jasper and L. Carmichael of Brown University and Bradley Hospital in research which confirmed in many particulars earlier work of Dr. Hans Berger of Jena, Germany.

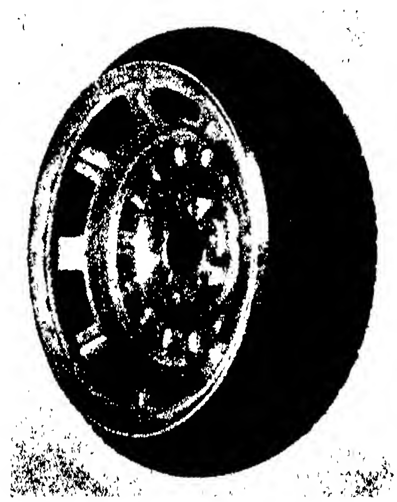
"Electro-encephalograms" is the name for the wavy line records of brain action currents, corresponding to electro-cardiograms, the name for the similar records of heart action now familiar to physicians and to many heart disease patients.

Two kinds of brain waves were detected by both Dr. Berger and Drs. Jasper and Carmichael. Change in size of the larger or "alpha" waves appeared under the influence of various factors such as anesthetics, epileptic seizure, stimulation of the sense of sight or hearing, and work on a "mental" problem. The waves are largest when the person is relaxed. Difference in frequency or lack of synchronism between one side of the head and the other appeared in some normal and especially in sick persons.—*Science Service.*

Attachment Cuts Blow-out Danger

A NEW invention for the motorists' safety is the Tire Guard, a wheel attachment that is said to eliminate all danger from blow-outs at any speed. This Tire Guard is the invention of Herbert V. Ludwick, wheel engineer and designer. The Tire Guard, according to the manufacturers, is really an extra inner wheel or rim that is attached to and becomes part of the regular wheel. When a blow-out occurs or a tire goes flat, the car simply rides on this inner wheel and there is no swerving or undue shock. The Tire Guard device, it is said, keeps the car under easy control when tire trouble happens, and in addition, no damage is done to rims, tires, or tubes.

Two views of the Tire Guards, under normal use and with a flat tire



The Tire Guard, showing how it is rigidly attached to the car wheel

Ralph De Palma, of racing fame, says: "Tire Guards, I believe, could have saved the lives of many fine racing men."

Yarns that Control Dye Absorbtion

RECENT perfection by research engineers of the Ewing-Thomas Corporation, Chester, Pennsylvania, of mercerized cotton yarns with controlled affinity for dye, has occasioned great excitement in the textile industry. Development of the new yarns, which are called Metro-Shade, is of great importance to the two largest branches of the textile family—cotton, one of the oldest known fibers, and the synthetic fiber group, youngest giant of the industry.

Once upon a time fabrics were loomed of silk or linen or wool or cotton. Today's fabrics are much more complex. More than 200,000,000 pounds of synthetic or man-made fibers were produced in the United States last year. The amazing diversity of modern fabrics is the result of combining these various fibers one with another and with natural fibers.

Once stockings were made simply of cotton or wool or silk. Today's stockings frequently combine several fibers, each neces-

sary because it best serves a particular purpose when all are combined in the finished product.

All of this brought about a serious problem to which answer has now been made. Each of these various fibers reacts differently to dye, and what to do about a stocking that comes out of the dye bath deep dark gray in the leg, and pale dirty gray in the foot? How best to achieve perfect dye union between various fibers knitted or woven together in wearing apparel has for years been the subject of intensive study and experimentation. Dye manufacturers have long sought the answer in dye formula modification, with only indifferent success up to the present time.

Ewing-Thomas technicians attacked the problem from the cotton point of view. After several years of experiment and research they succeeded in producing mercerized cotton yarns with either a heightened or a retarded affinity for dye. This was accomplished through control of the basic structure of the yarn as this structure relates to depth of shade in dyeing, says Henry A. Stafford of the Ewing-Thomas Corporation. Metro-Shade No. I processed for high affinity to dye is the answer to Bemberg yarn combined with cotton, while Metro-Shade No. II with retarded dye affinity is designed for use with viscose yarns.

Two facts involved in the Metro-Shade development are the appearance of the finished merchandise in which, of course, clarity, depth, evenness and fastness of dye are highly important, and the cost of the finished merchandise, in which dyeing is an important consideration. With Metro-Shade yarns, it is pointed out, single instead of multiple dye baths are possible, less dye is required to get results, and "seconds" or inferior merchandise, due to dyeing imperfections, are materially reduced, thus increasing production.

It is interesting to note also that color differentiation can now be achieved through use of the new yarns. Children's socks, for example, can now be candy striped in one dye bath simply by alternating Metro-Shade yarns with regular yarns. Very often, also, woven or knitted fabrics such as ribbons or gloves, not to mention beachwear, have cotton backs with synthetic fiber faces. Here again, Metro-Shade is highly important in the achievement of rich, even colors. And in case you have forgotten your Greek from which Metro-Shade derived its name —it means "combining of shades."

PROGRESS In This Age Of Science

As Told to SCIENTIFIC AMERICAN

By GERARD SWOPE
President, General Electric Company

A GREAT development we are looking forward to in the electrical art is the extension of the electron tube into the power field. Direct-current transmission of electric power has long been the quest of engineers and such power tube development may accomplish this in the near future. Direct-current transmission of power possesses striking advantages of control and stability, which would greatly simplify existing problems and greatly reduce present limitations in long distance transmission of electric power.

In the home and factory, electric power and heat already have largely reduced human physical exertion. Few, if any, are the household tasks that cannot be done electrically, and, we think, done better. Research and development in the electrical industry have continued and are preparing the way, through air conditioning, to far more healthful living in the office, in public buildings, and in the home.

Research in our own laboratories has been continued throughout the depression and will be continued in the future. It has a great stimulation to the art and progress in the electrical industry, and we believe new inventions and better methods are bound to be as great in the years ahead as they have been significant in the past.

FILM DEVELOPING IN THE AIR

THE Davidge Film Laboratory, of Hollywood, has created a new method of developing photographs, enabling fliers to put exposed films in process before returning to their naval base or airplane carrier.

Movie film-developing tanks used to process film strips while flying

The tanks are completely molded in Bakelite. Light is kept out of the tanks by a bypass which also drains the tank of its developing solution. The tank has met with considerable approval all over the world, some having been adopted by the Japanese Navy, with considerable demand created on the part of other countries. Other patented construction features produce absolute maximum of agitation insuring rapid uniform development of both high-lights and shadows with color separations and gradations that heretofore have been considered impossible. Film capacity is 25 feet of 35-millimeter film, or 50 feet of 16-millimeter stock. The amount of developing solution required is about 18 fluid ounces. It is stated that this small developing unit is also used by the professional cinematographer and sound recorder for tests of short lengths of exposed negative film while "on location."

GENIUS

THE declining birthrate in the professional classes need not cause us to expect social disaster, according to studies at Harvard of 3000 school children. These studies show that geniuses in largest numbers spring from the middle classes.

LUBRICATED RAISINS

SEEDED Muscat raisins are sticky, messy things to handle, as every housewife who has pried them out of a package knows. Yet they are mighty good raisins. So the raisin folk have devised a way to pack them that eliminates the old sticky, compressed block of raisin meats. They are now lubricating each raisin so that it is not sticky at all, but bright, shiny, and separate. It takes only a gallon of oil to lubricate a ton of raisins. And here's the best part of the idea—the oil is made from the seeds of the raisin.

The oil extracted from the seeds is refined to such a point that it can be used as a salad oil. It does not affect the flavor of the raisin, does not become rancid, and helps protect the fruit from insect infestation.

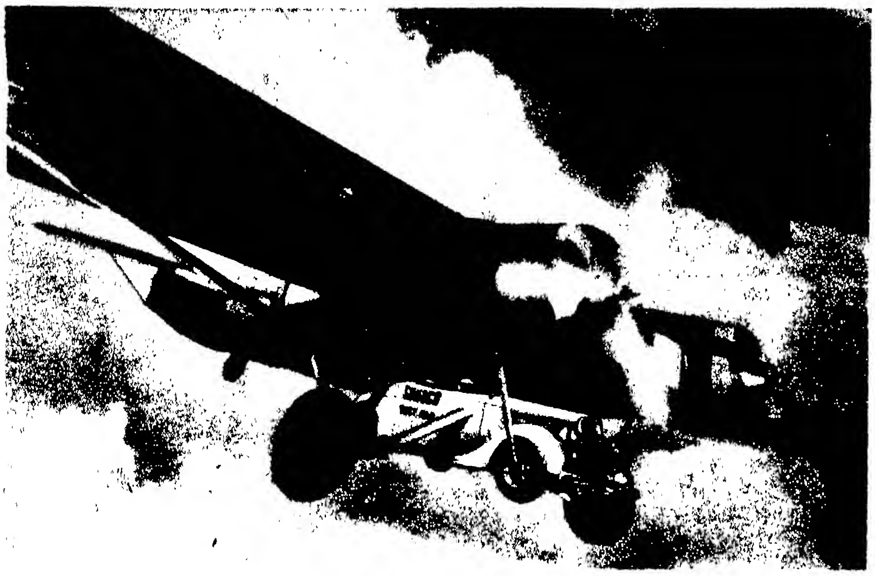
From 2000 to 4000 tons of cleaned, dried seeds are removed from California raisins each year. This makes more than enough oil to "grease" all the sticky raisins and to "shine up" the otherwise dull seedless varieties. The surplus oil is sold for salad oil, according to *Food Industries*.—*A. E. B.*

NEW SOLVENT FOR RUBBER

A SOLVENT for synthetic and natural rubbers has just been announced by E. I. duPont de Nemours and Company. This new solvent is beta-trichlorethane, a non-inflammable, water-white chlorinated hydrocarbon.

Besides its unique solvent power, beta-trichlorethane is a rapid and powerful solvent for such organic materials as oils, fats, waxes, tars and natural resins. It is miscible with alcohol, ether, and many other organic solvents, but is practically immiscible with water.

Other properties of beta-trichlorethane include a boiling point of 114 degrees, Centigrade, (237 degrees, Fahrenheit), a specific gravity of 1.4406 (12 pounds per gallon), and high stability in the presence



A motor car being carried by a Burnelli all-wing lifting fuselage plane in a recent spectacular test. This type of plane is described in these columns

of light and water. Because of this last property, it is non-corrosive to most materials of construction, an important feature in industrial applications.—*A. E. B.*

> **HAPPY LANDING!**
>
> **AIRPORTS and landing fields in this country totaled 2297 on January 1. Of these, 664 were partially or fully lighted for night use.**

All-Wing Lifting Fuselage

FOR many years Vincent J. Burnelli has been engaged in the application of an original and valuable principle—the Burnelli Lifting Fuselage.

Our readers will grasp from the illustration the essentials of a Burnelli transport. The fuselage is itself an airfoil blending into the highly tapered wing. The engines are placed at the nose of the fuselage itself without the necessity of outboard wing nacelles. The pilot and co-pilot are seated well behind the two propellers and the propellers are set very closely together, with tips just clearing one another in their plane of rotation. A great many advantages derive from these characteristic Burnelli features.

The passenger cabin can be made of relatively enormous width, commodious and comfortable, without the slightest sacrifice of aerodynamic efficiency. The airfoil-shaped fuselage does its own lifting, so that for a given gross weight and a given landing speed the area of the wings may be reduced by the full extent of the projected area of the fuselage. The area and length of the cantilever wings being reduced thereby, their structural weight goes down accordingly. Since the wing merges into the top of the fuselage, downward vision for the passengers is unimpeded. This is achieved in the ordinary high wing monoplane but then it is awkward to retract the landing gear. In the Burnelli design it is possible to retract the landing gear directly into the bottom of the fuselage, owing to the great width of the latter. Again, since the engines are so far ahead of the fuselage, a natural shock-absorbing system is provided as a safeguard to both pilots and passengers in case of a crash. The fact that the two engines in this arrangement can be placed closely together reduces the unbalanced turning moment should one motor go out of commission. On the first flight, the speed and control were excellent but the trials ended in a disastrous accident.

Moving pictures showed that the two ailerons fluttered, then came off; first on one side and then on the other. The right wing tilted downwards. The pilot "gunned" the right engine in an effort to pick up the low wing, but nothing could stop the roll. Soon the right wing tip crashed into the ground followed by the two engines, which were both torn from their mounts by the terrible impact. The experienced pilot, Lou Reichers, had cut his ignition switch and kept the landing gear retracted into the cabin floor. The crash, while regrettable, served as a remarkable demonstration of the strength and safety features of the airplane. The pilot himself, though shaken, escaped all injury. With the whole front of the ship acting as a vast shock absorber and with the rugged construction of the plane, the pilots' cock-pit and the passenger compartment remained virtually intact.

The Burnelli engineers, after careful investigation, have decided that the ailerons were not sufficiently balanced in weight about the hinge and that the dual control system was somewhat too flexible. A second ship of very similar construction, with the aileron system thoroughly revised, is being pushed ahead. With our sympathies to the constructors goes the confident hope that the new ship will soon be successfully completed.

In addition to the advantages enumerated above, the cheapness and simplicity of construction of the Burnelli transport has a decided appeal for certain of the airline operators who are watching these developments with considerable interest.

In a recent spectacular test of a Burnelli ship very similar to the one which crashed, a motor-car of the roadster type was carried below the fuselage as shown in the photograph. The purpose of this demonstration was to prove the possibility of using aircraft for high-speed transportation of small land vehicles or boats. In times of war, for example, small tanks might thus be carried to the scene of action and released at strategic points.—*A. K.*

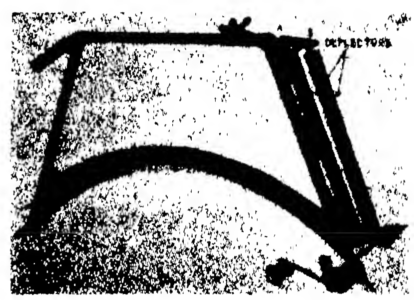
New Windshields for Bad Weather

THE windshield of an airplane is used to protect the pilot from wind and bad weather conditions while preserving an adequate field of view. The shielding is a comparatively simple matter, but obvious difficulties arise when rain, snow, or ice impairs the vision.

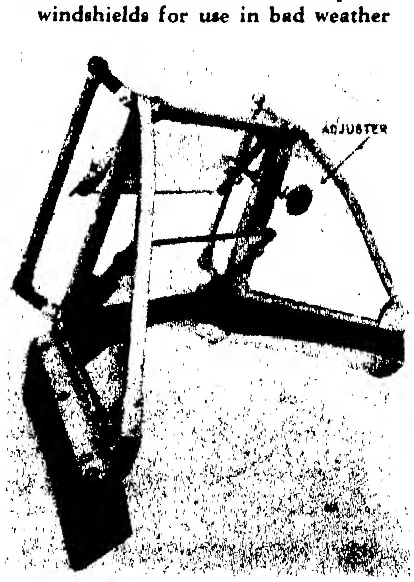
Sometimes these difficulties are met by mechanical windshield wipers. Attempts at electric heating of the windshield have been moderately successful. In enclosed cabin machines side windows are arranged to slide open so that the pilot may look out without an excessive draught being created.

In the open cockpit, heating is very difficult, and there are no side windows. The British Air Ministry has therefore made experiments with new types of windshields for bad weather, to be used in open cockpits, which are promising. Strictly speaking we should not say new windshields, but rather new accessories to the windshield.

In one type, deflectors, consisting of small airfoils, are placed at the side of the windshield and slightly ahead of the screen proper. When these deflectors were turned into the wind, it was found by scientific wind tunnel test that the velocity of the wind outside the cockpit but in the lee of the deflector was reduced to negligible proportions. Therefore the pilot could look out at the side of the cockpit without discomfort.



***Above and below:* Two airplane windshields for use in bad weather**



In another type the windshield is divided into two parts, and so arranged that the upper part can be staggered ahead of the lower part. Wind tunnel tests showed here that the air was deflected upwards without any perceptible draught being felt in the cockpit, yet vision through the opening was perfect.

While open cockpits are now rarer than was the case a few years ago, anyone flying in an open ship might do worse than to use one or the other of these two gadgets. —*A. K.*

New Aerial Towing Target

THE Matériel Division of the Army Air Corps has introduced a new type of towing target of considerable interest. The new targets are towed by manila rope in place of steel cable, as greater flexibility of operation and reduction of expense is obtained thereby. The main difficulty with these towing targets hitherto has been the fact that they reduced the airplane speed so much.

The old design was semi-dirigible in type, cone-shaped, closed at the rear, with the mouth held open by a large ring. Unfortunately, the weight of air imprisoned in the cone reduced the speed considerably. The new target is almost a straight sleeve, open at each end, and thus imposing very little drag other than the frictional drag of the fabric. Two sizes of target are available, one three feet in diameter and 30 feet in length for anti-aircraft practice, and one two feet in diameter and 15 feet in length for aerial gunnery practice.—*A. K.*

Precautions for Alaskan Flying

PACIFIC Alaska Airways have no easy task in operating in the region whose name they bear, and the Lockheed Electras employed by this company have a number of special devices to make them suitable for service in severe cold and rough country.

The types of engine shutters commonly used on aircraft protect only the crankcase. As can be seen in one of the photographs, the shutters of the Alaskan planes can shut off the cold air from the front of the engine completely and form part of the cowling ring. On the sides of the fuselage nose are mounted ice shields or abrasion shoes. These consist of rubber sheets covered with doped fabric and cemented to a frame of dural strip, which is itself riveted to the metal skin of the fuselage. Another accessory, employed as far as we know for the first time in connection with a retractible landing gear, is a bicycle-type mud-guard mounted over the wheels. Many a retractible landing gear has jammed because of mud and dirt, and this simple guard may avoid a serious accident. The sturdy chassis ends in a fork over the wheels and is retracted by means of a powerful gear.—*A. K.*

The various steps in attaching the Chair Chute described below

Parachutes for Transport Planes

A WELL known parachute designer, Floyd Smith, has sent us a well written and convincing statement in favor of the use of parachutes for passengers on transport airplanes in scheduled services.

Above: A retractible landing gear with mud-guard. *Below:* Monoplane designed for use in Alaskan flying

In most emergencies, says Mr. Smith, there would be ample time for individual parachute equipment to be attached and used, particularly with the special transport 'chute equipment now available. Examining the records of accidents, Mr. Smith shows definitely that there would have been both sufficient altitude and sufficient time for utilization of a 'chute in many such mishaps, with the consequent saving of many lives.

The Irvin Chair Chute is so designed that when not in use it fits into the back of the chair and is completely unobtrusive. The photographs show how quickly and simply the 'chute may be fastened. The passenger fastens the lap strap into place first. Then the lap strap is drawn tight, with ease and without disarranging the clothing. Then the chest strap is quickly fastened. The harness automatically adjusts itself to correct size as the passenger arises.

The freedom from accidents in jumps made by inexperienced persons indicates that to jump, wait a few seconds, and then pull the rip cord is not at all a difficult feat.

In some countries an automatic release is incorporated consisting of an extra cable coiled in a pocket on the pack with a snap on the free end, which may be attached to any suitable part of the plane before the person jumps.

It is also possible that the Irvin Chute Company will shortly place on the market an automatic rip-cord handle, which will release the parachute within a predetermined time, after a button is pressed just before the jump is made.—*A. K.*

FEWER PILOTS

STRANGELY, there was a drop to 13,949 of pilots holding active Department of Commerce licenses on January 1, 1935 as compared with 13,960 on January 1, 1934. Aircraft licenses also dropped—from 6896 to 6339.

Bradshaw's Air Guide

ANYONE familiar with traveling in Great Britain knows the enormously bulky Bradshaw's Railway Guide. Now No. 1 of Bradshaw's International Air Guide, a book of some 176 pages, has made its bow to

the public. It is remarkable how well the whole of Europe is now covered with air-lines operating on regular schedule; fascinating to look at the map of Europe and read of the cities which can be reached by air: Oslo, Sweden, and Leningrad, in the extreme north; Sicily and Crete in the extreme south; Damascus in the east; Cairo in Egypt. The possibility of flying over the classic Mediterranean or the age-old Pyramids is certainly tempting to the American tourist.—*A. K.*

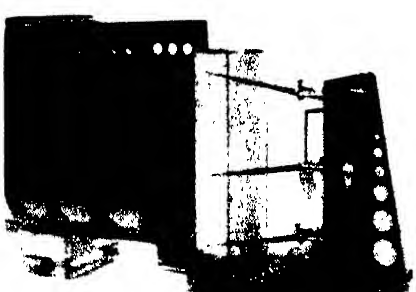
Altitude Flying Will Improve Weather Predictions

CLIMBING to altitudes of over three miles, Army, Navy, and commercial pilots will now carry instruments aloft with them each day from 20 different airports to record conditions in the higher air and give United States Weather Bureau experts increased data on which to base their forecasts.

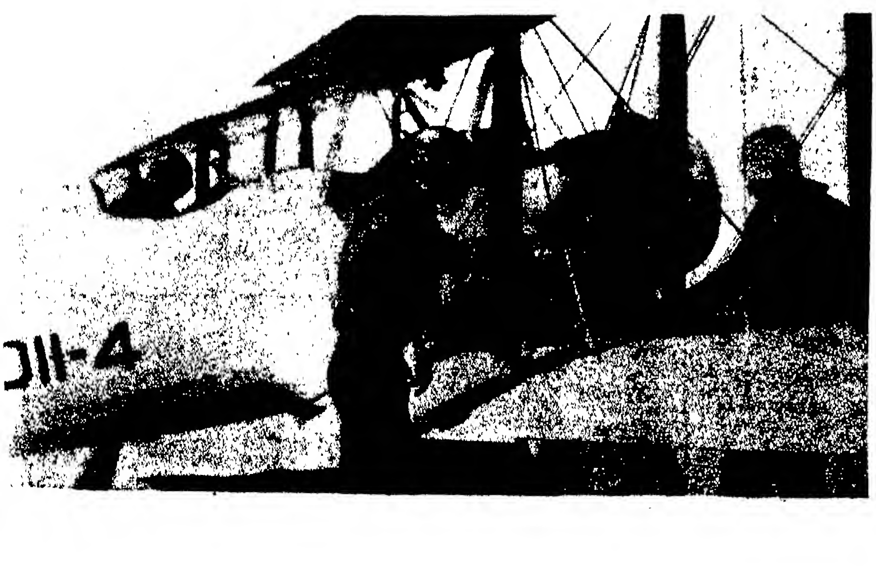
For the past two or three years commercial pilots have been making daily jaunts above the clouds to take observations for the weather man, but up until a short time ago, mass analyses of the upper air have not been conducted on a large scale.

Each observation pilot has attached to the wing of his plane a meteorograph, an instrument which automatically records humidity, temperature, and pressure. These are the three "R's" in the science of predicting the waves, eddies, and cross currents of that turbulent sea, the atmosphere. In addition, the pilot notes the altitudes of the top and bottom of cloud banks, the positions and altitudes of rainstorms which pelt down into dry strata of air and never reach the ground, and local disturbances such as thunderstorms or dust clouds. Pilot balloons sent up from the ground and watched through precise telescopic instruments furnish a method of finding accurately the direction and speed of different layers of air as the small, gas-filled spheres rise through them.

Of the many services, regional and national, which the United States Weather Bureau performs, Dr. C. C. Clark, Acting Chief, considers that the use of extensive airplane observations at high altitudes will be most important to commercial and military air travel. Pilots will know more definitely what lies ahead when they hop off; they will know whether they can climb to a desired altitude without encountering a snow squall or head wind, or whether danger lies before them.—*Science Service.*



Above: **Meteorograph.** ***Below:*** **The instrument mounted on an airplane**



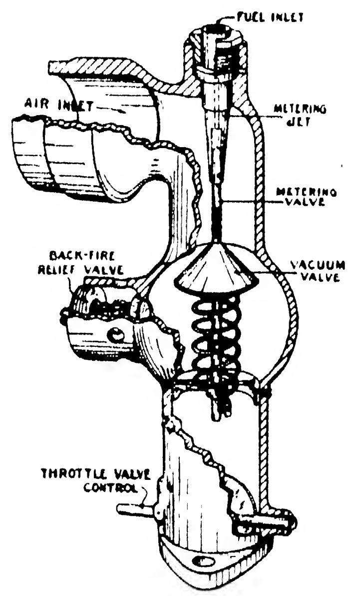
Floatless Carbureter

ONE of the photographs and a drawing herewith illustrate a new carbureter entitled the Vac-U-matic, invented by Lee Bowman, a designer of low-powered aircraft engines. It is a well-known fact that for an engine of any type to be economical, the ratio of gas to air in the mixture has to be just right at any speed. It is claimed for the new carbureter, of which many tests have been made, that it will always maintain the correct mixture.

The Vac-U-matic is a dry carbureter having no float, no gasoline reservoir, no adjustments, or idling screw arrangements. There is only one casting and one moving part. It is particularly suitable for aircraft use because it cannot flood in any position that the airplane may take up.

In operation, the suction developed by the engine pulls the vacuum valve away from its seat against the spring, which permits the passage of air into the manifold and into the cylinder. The vacuum valve is resiliently connected with a simple metering jet by means of a metering valve. This plunger moves simultaneously with the vacuum valve. Thus the engine by its suction regulates the amount of mixture drawn in by the throttle, and so maintains the proper ratio of fuel and air at all speeds. Tests have proved that the carbureter never chokes up, never gets too rich or too lean, because the vacuum cone reseats itself when back-pressure develops. With the flame forced out through the back-fire relief valve the dangers of back-fire are largely eliminated.

Above: **The floatless carbureter described here, and,** ***below,*** **a diagrammatic section, showing the parts**



While qualitative tests have been entirely successful, the quantitative tests of power and economy under varying fuel loads will be awaited with much interest.—*A. K.*

Aluminum Paint as Primer

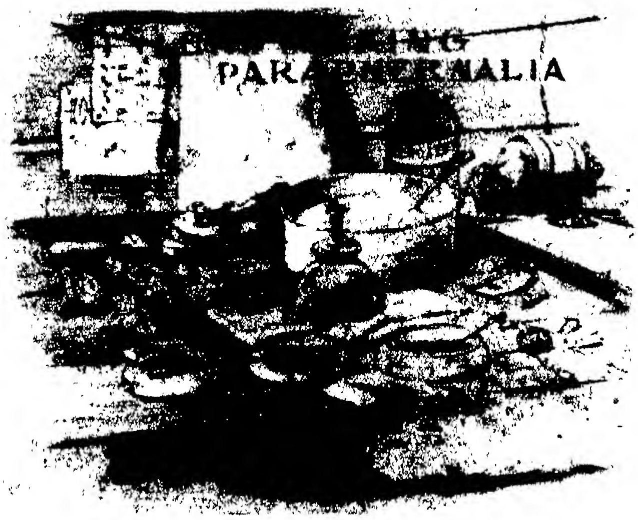
WRITING in a recent issue of *Industrial and Engineering Chemistry,* F. L. Browne, United States Forest Products Laboratory, says: "Repeated comparisons of the durability of white paints on wood when applied in the customary manner, using the white paint itself for the primer, consistently demonstrated a distinct superiority in service for paint applied over aluminum primer. The improvement in durability was manifested by a retardation in the rate at which paint coatings, embrittled with age, flaked from the bands of dense, horny summer-wood present in

(Please turn to page 211)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

HERE is a whole new chapter of interesting material written by Russell W. Porter of the California Institute of Technology, with an accompanying batch of his own drawings. He entitles the story "More Small Lens Wrinkles," and intends it as a follow-up to his chapter on eyepiece making, contained in the book "Amateur Telescope Making." He writes:



"JUDGING from the letters I receive from men who have made their mirrors, and are now contemplating or actually making their eyepieces, it would seem that an increased interest has sprung up among amateurs who desire to complete their entire telescopes with their own hands. I have for years urged mirror makers to try their hand at small lens making, telling them that the difficulties are no greater, and that the fun is just as great. I have picked up a few more ideas on the subject since writing the chapter on eyepieces (page 66, 'Amateur Telescope Making,') and am here offering them to the 'fraternity,' along with a description of the spindle I have been using here at Pasadena the past four years.

"Figure 1 shows the general set-up, the spindle and motor bolted to a cast iron slab. The motor is 1 h.p. (1725 r.p.m.) giving ample power for the larger work running up to 2½″ diameter. The spindle is 6″ long, 7/8″ in diameter and runs in ball bearings. The dish *A* is removable, and a horizontal stud at *B* allows turning the spindle easily into a horizontal position for centering work. The dish can be clamped, *C*, in any azimuth so as to bring the lever arm *D* to the most comfortable position. The lever arm is provided with a universal joint *E*, and the rod itself can be slid sidewise and rocked, so as to bring the pin *P*, carrying the lens, to just the right place over the lap. Two pulleys on the motor and two on the spindle, of 5/8″, 1″, 1½″, and 2″ diameter, allow a wide range of speeds for the different sized lenses.

"I experienced trouble with the belt, trying different materials in order to obtain the smoothest action and longest life. The one on the machine now is the most satisfactory. It is leather, round, and has no joint, and was cut from a strip of 4″ belting (*a*, Figure 6). Slots in the base permit taking up the stretch. My last addition to the machine is locating the starting and stopping switch *F* within easy reach—for the left hand is usually occupied holding the lever that controls the spinning lens—also the provision of a brake *G* for quickly bringing the motor armature to rest.

"The amateur, in attempting his own machine, may well disregard certain features shown in my design, for this instrument was made with the resources of a large machine shop. The patterns are all expensively cored, the castings aluminum. But the essential features should be retained—namely, a smooth running spindle (plain bearings will do, but must be kept carefully oiled and protected from grit), a smooth running belt, a detachable dish, and provision for bringing the spindle to a horizontal position.

"With the machine so described it is unnecessary to depend on a lathe for turning up the various curved surfaces on the brass laps, for you are virtually already provided with a speed lathe set up on end. A very little practice with a hand tool made out of an old file, using the lever arm as a steady rest as shown in Figure 2, will form a lap in a few moments so that it fits its templates.

"Of course, for good work, the laps should be made in pairs—male and female—and ground together. Much time will be saved in holding the laps to their correct curvature, if the bulk of the glass has first been removed from the glass blank, before placing it on the machine. (See A.T.M., p. 67, Figure 53*b*.)

"I am now using four grades of abrasives: Nos. 90, 1F, and 600 Carborundum, and 305 emery. An addition of an equal amount of talc to the emery will almost surely prevent scratches in the final grinding. It leaves the glass with a surface that comes to a polish in a few moments. Scratches usually show up with 600 Carbo. A fruitful cause is letting the lap become too dry. It doesn't take long for the rapidly rotating tool and spinning lens to move the lubricant away from their central areas. Should the worst happen the lens will seize to the pitch, the pin on the lever arm will jump out of its pivot, and the lens may fly off into the dish and very likely suffer a chipped edge. Perhaps a hardwood dish, or a dish of some material that will cushion such a blow, would be advisable.

"I find it pays to do some thorough house cleaning when changing from one grade to one finer, also that it pays to put down fresh newspapers, to scrub the hands well with a scrubbing brush and clean the finger nails. My four grades of abrasives are kept in four glass cups—caster cups—(at the five-and-ten, at a nickle each). I ground their edges on a sheet of window glass, then cut up the window glass into cover plates.

"IN polishing I cover the tool, or lap, with only about 1/16″ of rather hard pitch and, while still warm and rotating on the spindle, smooth it up to shape with its mate (wetted). The prepared fine-ground lens will do about as well. The rouge polishes faster if the pitch is rechanneled often. It only takes a moment with the blade of a pen knife, and Figure 3 shows the way I do it. The pitch at the center of the tool can well be removed, for it permits the pitch under pressure to flow toward the center as well as the edge.

"The tyro must work out his own salvation until he knows just how far to let his spinning lens move away from the center of the rapidly revolving tool, in order to have the polish come up evenly on the glass. He will notice that with the center of the lens directly over the center of the tool, they are both going at the same r.p.m.—they are as one—and no action is taking place. Theoretically, and, assuming perfect contact and also assuming that the tool retains its shape (which it never does), a position for the lens center from the tool center will be found when the lens

Figure 1: **General set-up**

ceases to spin and comes to rest, and beyond that critical point it will start spinning in the other direction. But pitch, as mirror makers know to their sorrow, is queer stuff, and possessed of seven devils, and one must find for himself about how far the lens should pass across the tool.

"What is actually taking place between the glass and pitch surfaces is rather complicated. In Figure 6*b*, with the tool rotating

Figure 2: **Turning a brass lap**

anti-clockwise as shown, the areas on the tool at *A* and *C* will tend to give the lens the same rotation as the tool. But around *B* the tendency of the tool is to turn the lens in the opposite manner, namely, clockwise. Moreover, heat is being generated, the pitch is flowing, and the slope of the surfaces is continually changing with the stroke.

"In general it can be said that enlarging the central cavity in the tool will bring more of the polishing action to the outer parts of the lens, and trimming down the size of the tool to less than that of the lens will have the opposite effect. The length of stroke is, of course, important.

"As with mirrors, it is desirable to remove the lens as few times as possible. I use a match-stick to apply a drop or two to the lap when necessary. By carefully moving the spinning lens so as to expose as much of the center of the tool as is safe, the rouge is applied at the center and allowed to work outward by centrifugal force.

"The danger of producing zones by paring away the tool at center or edge might argue for a full-sized tool, uniform throughout, the exact counterpart (obverse) of the lens surface itself. Zonal irregularities become apparent when two lenses with contact surfaces—say flint and crown of an achromatic doublet—are viewed under monochromatic light. The interference rings are not evenly spaced, there are too many of them, and they depart from circles as the lenses are moved eccentric to each other.

"CENTERING comes next. When the lenses are polished, the dish is removed, the clamping nut *H* (Figure 4) unscrewed and the spindle brought horizontal. For centering I use an attachment (Figure 4) that slips over the seat formerly occupied by the dish. This gadget comprises the rod *K* carrying the edging plate *L* and a screw *M* acting against an arm of *K*, and the guard *N*. The right adapter (*A* in *c*, Figure 6) is pressed on the tapered spindle end and a little hot pitch daubed on the flange at *B*. With the flame of a bunsen burner (Figure 5)—an alcohol lamp will do as well—the adapter and spindle end are given a warming and the lens cemented

(*Next page, please*)

THE AMATEUR ASTRONOMER

(Continued from preceding page)

against the flange *B* (Figure 6 *c*). By giving the spindle a few turns and looking at the lens, the reflections from the lens (of different parts in the room, lights, and so on) will be seen to wabble. The lens is then moved a trifle on its seat and the spindle again given a turn. If you have reduced the wabble—if the reflections show less movement—you moved the lens in the right direction. If not, and it has increased, you have made a bad matter worse. A few tries and the secret is out and you know which way to move the lens to reduce the wabble and finally to wipe it out altogether. What you see in the lens as it rotates remains fixed. The axes of the spindle and the lens coincide. Probably the pitch has cooled off before the job is done, but a few passes of the flame allow the adjustment to be carried on indefinitely.

"We are now ready to edge the lens. On goes the edging plate *L* (Figure 4), and the screw *M* is advanced until the edging plate just touches the lens. The dish is placed as shown, with some 1F Carbo and water in it, and a spoon. The motor is started, the guard *N* dropped and the Carbo spooned on to the edging plate. As the plate is brought to bear on the lens under the action of screw *M*, and the Carbo is dragged under the lens edge, the ear detects a vibration of the plate due to the pounding cam action of the lens. In a short time, as the glass wears down, this pounding disappears and one has only to watch with an outside calipers (*O*, Figure 5) for the lens to come down to the required diameter. The lens is removed under a little heat, placed in kerosene (or gasolene) over night, when it can be washed clean with soap and water.

"What I have here described (as well as in Chapter XI, Part I, A.T.M.) are the wrinkles and methods worked out by myself without being prejudiced by a knowledge of professional practice. Undoubtedly some of them will appear crude and amusing to the professional. For example, it may be that a better way of making a lens run true on a spindle is to use a fork (*d*, Figure 6) and, as explained on pages 69-70, A.T.M., I have used them both, but I remember a bad scratch that developed when I used the fork. There may be other simpler and more orthodox ways, but it's been lots of fun working out one's own technique.

"To me a lens is a wonderful and beautiful object, and I shall be well repaid if what I have described will start others of our now large following of telescope makers to try equipping their instruments with their own oculars."—Pasadena, California, December, 1934.

Figure 3: Rechanneling the lap

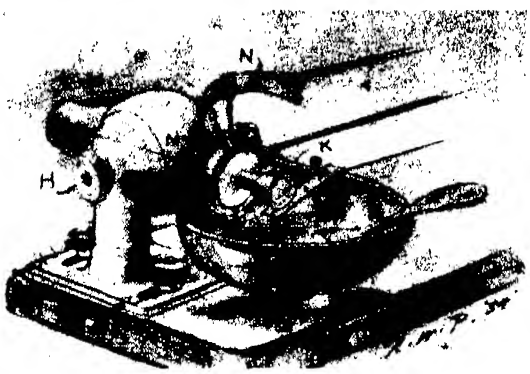


Figure 4: **The centering gadget**

We nominate Mr. Porter's article, above, for inclusion in the new "A.T.M. Supplement."

And what is the new "A.T.M. Supplement"? It is something that, as yet, isn't. It is something that is to be. We plan to publish, next fall, a companion volume to A.T.M., similar to it in binding, format and typography but thinner—perhaps 128 pages. Into this we shall pour a general collection of items long and short, which we either have on hand or can think of, such as reprints of articles on telescope optics, odd data, more "contributions from advanced amateurs," and general material of use to telescope makers, all brought together in one book, an *omnium gatherum.* Reprinted items from past numbers of the present department may also be included. This book will be sold either with A.T.M. or separately, as desired. We have already started to assemble the ingredients of this book, but we want also to get the ideas of our readers, concerning what they think ought to be put into it to make it a round peg in a round hole.

Figure 5: **Centering the lens**

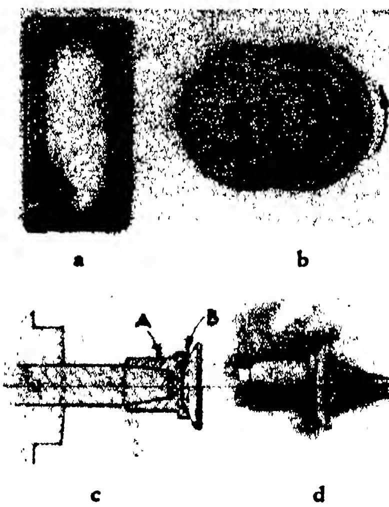


Figure 6

Above all, we want this to be a practical book—no articles on purely theoretical optics or about the pretty stars. Tentatively, we think there should be a good, solid section on telescope mounting design. Whom do you nominate that is qualified to contribute that section? A short section on making setting circles; we have one or two small things on this already, but who has further material? Who can furnish a compact chapter on clock drives—not merely about them but telling exactly how to make them? What other subjects need coverage and who will cover them? Gentlemen, name your poison. We solicit your advice but do not guarantee to take it! And we must move with celerity. Write to us.

Last month, after your scribe had read and passed, supposedly to the printer, the final proofs of the pages for this department for the March number, a nefarious gang of his fellow editors (or fellow clowns) secretly conspired to insert his photograph in these pages, under a caption which read "The Mentor of the Amateur Telescope Makers." In an accompanying note they accused him of modesty, an unscientific statement which is also libelous, and they even called him a gentleman. The very picture itself was a libel, being one which they are believed to have scavenged from a waste basket after your scribe threw it there because it too closely resembled that of Al Capone. In brief, the only accurate statement connected with this whole deep-dyed plot was the assertion that your scribe would not see the picture in the magazine until too late; and this is the very assertion that, with sad, wet tears in his voice, he is dead certain nobody on earth will ever, ever believe—no, never. And did not the conspirators know that very fact? Aye, they even admit it, and they actually laugh about it. Your scribe's most fervent disclaimer, they say, will merely be regarded as a part of his original put-up job, and so will all further disclaimers, right on out to infinity and beyond.

In these heart-rending circumstances, with his spirit crushed, and in a hopeless fix, your despairing scribe has picked out a nice hole, is now about to crawl into it and pull the hole in after him. Goodbye, goodbye—alas, goodbye forever!—*The Dementor of the Amateur Telescope Makers.*

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page 206*)

softwood lumber. The benefit gained by priming with aluminum paint was greatest for woods that have much summer wood, such as southern yellow pine and Douglas fir. When repainting was neglected for some time, coatings applied over aluminum primer suffered less damage and the surfaces were then more easily and durably repainted."—*A. E. B.*

HEAVY-WEIGHT

A three-year-old English boy who weighs 140 pounds has been reported to the *British Medical Journal*. Doctors have not decided upon the cause of the excess weight in this particular case but most believe that he is suffering from a gland disorder known as Frohlich's disease.

Dyed Sponges

For years many attempts have been made to discover a dye which could be used on natural sponges. It was recognized that such dyed sponges would have so much better eye appeal that they would be able to compete more successfully with the artificial kind.

Such a dyed sponge has now been placed upon the market. It is guaranteed to be of a genuine Sheepswool variety, "Sheepswool" being the designation of a very soft and clean ocean sponge. These new sponges in various pastel shades are wrapped attractively in Cellophane and may be found in most any department store.

Japanese Fish Tell Whether Baby May Be Expected

After discovering a male that puts on a "wedding dress," it was only one step further scientifically to find in his mate a lady who responds immediately and obviously to prospective motherhood. This interesting couple is Japanese and belongs to a family of fish called the bitterlings. Mr. Bitterling's change of outfit during the breeding season has been found to have a limited use in medical science. Mrs. Bitterling's odd practice of suddenly elongating a tiny projection from her body is now believed to possess important possibilities in medicine, among them a speedy test for pregnancy.

At the obstetric and gynecologic clinic of Prof. N. S. Heaney, Rush Medical College, Chicago, three physicians, Drs. A. E. Kanter, C. P. Bauer, and A. H. Klawans, have been using the female Japanese bitterling to make pregnancy tests on their women patients. Results are so promising that a preliminary report of their work is carried in the *Journal of the American Medical Association*.

Less costly in laboratory funds and ani-

mal life than the Friedman and Ascheim-Zondek pregnancy tests now in use, this fish test is expected by its authors also to surpass in clinical advantages. The other two tests must be done on rabbits and mice, and to complete them the animals have to be operated on and destroyed. Not so with Mrs. Bitterling. She sends out her little flag of motherhood over and over again, with a two or three week interval for recuperation. The fish are inexpensive and easy to maintain because they take a small amount of space, food, and care.

The physician or laboratory worker places a properly selected fish in a bowl containing a quart of water and a small amount of kidney secretion from the woman patient. Usually within the first 24 hours, the fish flies her signal by quick growth in the little oviduct which protrudes from her underside. The other two tests mentioned require two or three days for completion.

USELESS

FRUSTRATION of purpose seems symbolized in a new variety of evening primrose which develops full-sized buds but never opens them. This plant was recently found among a group of experimental plants by Dr. George H. Shull of Princeton University.

MOST POWERFUL ELECTRIC LOCOMOTIVES

A TOTAL of 57 streamlined electric engines, to be the most powerful electric passenger locomotives ever built in the world, are now being constructed for the Pennsylvania Railroad. Costing almost 15,000,000 dollars, these new giant electrics have been specially designed for the railroad's high-speed passenger service which was inaugurated between New York, Philadelphia, Baltimore, and Washington early in 1935. They will be capable of making a regular operating speed of 90 miles per hour, and will haul trains of standard size and length. Twelve 57-inch driving wheels, six on each side, will drive the fully streamlined, articulated engines along the tracks with full power of 4620 horsepower at high speed.

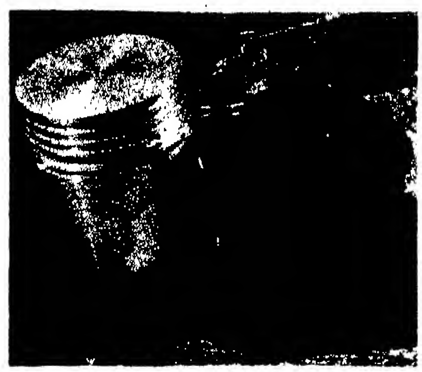
Each end of the locomotive will slope gently inward from the floor to the cab roof, with rounded shoulders running toward the central operating compartment. The engineman's control position will be at the center of the cab, giving unobstructed view of the track and making possible a design of the cab extremely pleasing to the eye.

Eighteen complete chassis will be built at the Pennsylvania's Altoona shops, and that works also will apply the electric propulsion and control apparatus to the chassis of 25 additional engines. Twenty-five chassis, to be equipped at Altoona, will be built at the Baldwin Locomotive Works at Eddystone, Pennsylvania. The General Electric Company at Erie, Pennsylvania, will build 14 complete locomotives, and the electric propulsion and control apparatus for nine additional engines. The Westinghouse Electric and Manufacturing Company at Pittsburgh, Pennsylvania, will build the electric propulsion and control apparatus for 34 locomotives.

Each locomotive will cost in the neighborhood of 250,000 dollars.

The Pennsylvania's new passenger engines will be 79½ feet long, of all-steel construction, and will weigh 460,000 pounds. Each will operate on an 11,000-volt, 25-cycle, single-phase system, the current to be fed by overhead wires through a pantograph. The maximum starting tractive effort will be 72,800 pounds.

One of the new giant electric locomotives described above



Upper right: New black alloy piston and a standard type. *Left:* Photomicrograph of a scratch on an untreated piston. *Right:* Same diamond point leaves no noticeable scratch on a treated aluminum piston

BLACK ALUMINUM ALLOY PISTONS

THE latest step in the evolution of the aluminum alloy piston is Alumiliting—a process which forms a hard, smooth aluminum oxide surface as an integral part of the piston. This surface has fine bearing qualities and materially increases the resistance of the piston to scuffing. The life of a piston thus treated is substantially lengthened; cylinder wall wear is reduced.

The engineers of Aluminum Company of America are responsible for the development of this piston. The hard surface is obtained by electrolytically treating the piston by the Alumilite process. The aluminum alloy pistons are electrolytically treated in large tanks; the equipment resembles that used for electroplating. If desired, the operation can be made fully automatic and continuous. Machining and grinding are done before treatment and the thickness of the Alumilite finish can be controlled uniformly and within close limits. The outside surface is made out of the metal and is not a layer of material deposited on the surface. This accounts for the tenacity with which it adheres to the piston surface and explains why there is little change in diameter during the treating process.

The Alumilite finish has the hardness and smoothness of a fine bearing surface. In addition, it contains innumerable invisible surface cavities which absorb oil, and the importance of this, when the engine is first started, is recognized. The hardness of the Alumilited surface is of material benefit in reducing ring-groove wear and in maintaining piston pin bore diameters within their original limits. Unusual protection against scuffing is obtained.

PSYCHOPATHIC LEADERS

LEADERS, followed and even revered in their time, are often "the most bizarre of the psychopathic types" of the period in which they live. Dr. Ruth Benedict in her illuminating ethnological study "Patterns of Culture" does not exempt some of those personality patterns which have played important parts in American development.

"The Puritan divines of New England in the 18th Century," she writes, "were the last persons whom contemporary opinion in the colonies regarded as psychopathic. Few prestige groups in any culture have been allowed such complete intellectual and emotional dictatorship as they were. They were the voice of God. Yet to a modern observer it is they, not the confused and tormented

women they put to death as witches, who were the psycho-neurotics of Puritan New England. A sense of guilt as extreme as they portrayed and demanded, both in their own conversion experiences and in those of their converts, is found in a slightly saner civilization only in institutions for mental diseases. . . ."—*Science Service.*

SALESMAN BUYS SAMPLE

AN aluminum salesman received a request to call on a certain customer. Upon his arrival he found that what the customer wanted, and wanted in a big hurry, was a small piece of aluminum about .00035 of an inch thick and perhaps five or six inches square. Thinking fast, the salesman asked the customer if he had a nickel in his pocket. The customer had. Whereupon the salesman took it, stepped out to a near-by store, purchased a chocolate bar. Returning, he removed the aluminum foil wrapping from the chocolate bar and handed it to the customer.

Then he split the confection with him and a good time was enjoyed by all!—*Aluminum News Letter.*

CRICKET HOUSES FOR CRICKET FANCIERS

DID you ever see a cricket wash her face, comb her hair, eat her dinner, or lay an egg? If you have never owned a pet cricket, you have missed a lot of fun.

A new-style patented cricket house is not only arranged for convenience in feeding the crickets, portability, and ventilation, but is made so that a high degree of visibility is possible at all times. Through its two vertical glass sides that hold in place the soil filling, the activities of the lively growing crickets are always in view, and many of the eggs laid by the females are plainly visible beneath the surface of the soil. One female cricket will lay as many as one hundred and fifty eggs in one of these houses. Not only can the eggs be seen in the soil, but the actual laying of an egg may be closely watched without disturbing the tranquillity of Mama Cricket.

You can see the growing crickets "change their clothes" of brownish-black and appear in a nice new suit of light-straw color. It usually takes a cricket about 15 minutes to make this change, and within two or three hours after the change has been made the new light-colored suit will turn nearly black.

ANGORA *Is* ANGORA

WHEN is an Angora not an Angora? This seemingly foolish question was involved in a recent proceeding brought by the Federal Trade Commission against the Joseph Benn Corporation, a prominent yarn manufacturer of Greystone, Rhode Island. The Benn Corporation used the name "Angora" to describe yarns made entirely of Angora goat hair. The complaint issued by the Commission alleged that this was an unfair method of competition and that "Angora" only applied to rabbit hair. On January 25, 1935, after the taking of extensive testimony, and after reading the briefs and hearing the arguments of counsel, the Commission dismissed the com-

Reproduced from page 95 of
THE FINGER PRINT INSTRUCTOR, by Frederick Kuhne, Bureau of Criminal Identification, Police Department, City of New York—$3.15 postpaid.

FIG. 47

AN ENLARGED FINGER PRINT

Numbers 1, 5, 33, and 34 are described as short ridge lines; 2, 9, 14, 16, 19, 20, 25, and 32 as a bifurcation of ridges; 3, 4, 6, 7, 8, 10, 11, 13, 17, 18, 21, 23, 24, 27, 28, 29, 30, and 31 as abrupt ending ridges; 15 and 26 are called islands; and 12 shows several small ridge dots and ridge terminations caused by a cut.

JUST as in the Hauptmann trial, finger prints are always of vital importance. Although everyone may not qualify as a finger print expert, everyone should be interested in the study of prints. It is both fascinating and scientific. The Finger Print Instructor was prepared as a text book for the guidance of experts and is generally used by police departments for training. It is simply written, comprehensively illustrated, and includes questions and answers for comparison and self-examination. It is, therefore, a complete, authoritative instructor for all persons interested in finger prints. If you are considering a stimulating scientific hobby, a study of this book will provide you with all the essential information. It is easy to read, easy to understand, and the directions on how to apply your knowledge are easy to follow.

The book is divided into three parts:

PART 1. Finger impressions, their uses, description of the various patterns, the taking of prints, and their classification.

PART 2. Making comparisons and the filing of prints, with schedule of various classifications in their order of filing, preparing cases for court and powdering impressions.

PART 3. Questions relative to the finger print system, with their answers, and plates or illustrations showing various patterns, etc.

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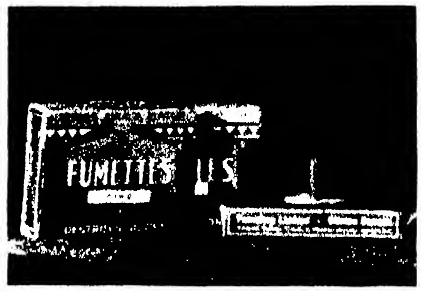
plaint against the Joseph Benn Corporation, thereby affirming their right to use the word "Angora" to describe yarns made of Angora goat hair.

From this it would appear that in spite of all the flux and change in modern times an Angora is officially still an Angora.

DEODORIZER

ODORS about the house, and especially those left after cooking strong foods in winter time when it is too cold for proper ventilation, are disgusting not only to the family but more so to visitors who may be present. Various fumigants and deodorizers have been used to destroy such odors



Deodorizer "match sticks"

but more often they simply blanket the odor with a more powerful scent of some kind. In cases where such things as incense are used, the resulting combination of odors is frequently more obnoxious than the original.

We have just had the opportunity of testing a new deodorizer which seems to fulfill its purpose admirably and leave but a slight scent of its own. This deodorizer comes in the form of matches, the long heads of which are a composition of black material. When struck as one would strike an ordinary match and inserted in a hole in the box container, these Fumettes, as they are called, smolder without flame for two or three minutes. Each one effectively clears the air of such odors as those remaining after cooking fish or cabbage. They are sold in boxes of 30.

TREASURE TROVE

THE treasure in a pirate cave in an island off the coast of Spanish Honduras consisted of broken rum bottles knee-deep. This was one of the archeological surprises found by Dr. W. D. Strong of the Bureau of American Ethnology. Rum fellows, those pirates!

LONG DISTANCE THERMOMETER

THE chemical engineer can now sit at home in the suburbs and see just exactly what is going on in the vats and tanks of his plant, miles away. The Bristol Company has introduced a new device known as the Metameter, for the indication and recording of temperatures, pressures, levels, and other process conditions or operations at any distant place, up to several thousand miles from the detecting instrument. The Metameter combines a transmitter, an electrical circuit for conveying

the impulses to the receiver, and a receiving instrument which mechanically translates the impulses received into the measurements made. These are recorded continuously on a 12-inch chart. The durations and not the intensities of the transmitted impulses are proportional to the values measured. Therefore, neither voltage fluctuation nor the resistance of the line affect the accuracy of recording and only a two-wire circuit, such as existing telephone lines, is required.—*A. E. B.*

JAIL NEST

MOTHERHOOD means a six-months' jail sentence to the female of one species of African hornbill. The male bird seals the female into her hollow-tree nest and feeds her and her brood through a narrow slot in the clay wall of her voluntary prison.

Splash and Drip Proof Motor

CONDITIONS in many industries frequently make it impossible to place electric motor drives where water will not be splashed, or will not drip onto the motor frame. For such applications Westinghouse has developed squirrel cage motors completely protected against splashing and

A stream of water from a hose fails to penetrate this water-proof motor

dripping liquids. The motor frame and the end brackets are solid cast iron, to resist the effects of moisture. An efficient system of baffles in the bearing brackets allows ample ventilation yet prevents liquids from entering the motor interior.

Drug Addiction Fought by Science

THE dramatic nation-wide drive against drug addiction being carried on by federal law enforcement agents is being paralleled by an attack on the same problem by medical scientists. If the scientists succeed, there will be no further need for the legal fight, because the scientists are pushing ahead in efforts to achieve a non-addicting substitute for morphine.

The biggest advance in this scientific fight is the production in the University of Virginia laboratories by Dr. Lyndon F. Small

of a new derivative of morphine, called di-hydro-des-oxy-morphine-D, which is 10 times as effective as morphine in relieving pain. In the recent announcement of the patenting of this drug, Dr. Small and colleagues with true scientific caution refused to state any opinion as to its possible addiction properties. Their studies of the drug have been made on monkeys and the question of addiction in humans can only be determined by observing its effects on humans.

This crucial point is about to be tested in the following way: Patients suffering from advanced tuberculosis and severe cancer are sure to become addicted to morphine because that is the only drug which will relieve their pain and cough. A group of such patients will be given the new drug to relieve their suffering. If they fail to develop addiction to it, this new drug with the long chemical name will be hailed as the long-sought, safe substitute for morphine and possibly as an aid in the prevention of narcotic drug addiction. If it can be used in the case of persons already addicted to narcotic drugs, it might aid in their "cure."—*Science Service.*

Amateur Microscopy

ALTHOUGH the German speaking countries, where they take their science very seriously, have the popular but scholarly magazine *Micro Kosmos* for the amateur microscopist, no similar magazine for the lay reader has been published in the English language, and many have felt the need of one. Into this gap, now that good microscopes for amateur needs are inexpensive and plentiful and many amateurs possess them, there comes a new journal, *Practical Microscopy*. Because of the good standards set by the first numbers of that magazine, we are glad to welcome it on behalf of many potential readers.

No doubt, in a few years, a body of serious-minded amateur microscopists sufficient to form a nation-wide organization, will have grown up in this country, and nothing will build it up more rapidly than the availability of a sound organ, devoted to the popular and semi-popular interpretation of authoritative microscopical science. This the new journal appears to be.

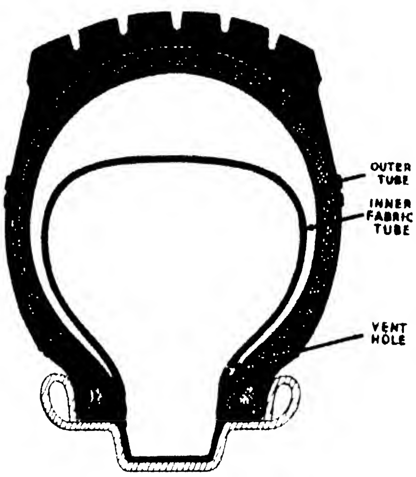
Quick-Freeze Keeps Cheese

THREE years of experiment at the University of Wisconsin have revealed that quick freezing can be applied to cheese, reports *Food Industries*. The procedure is to cure the cheese and freeze it in small units for distribution to consumers. Quick freezing has been found to preserve the quality of the natural cheese and holding the produce in cold storage delays spoilage in the package due to mold growth, leakage of fat, or change in quality.—*A. E. B.*

Double Tire-Tube

RUBBER companies have been concerned with the problem of tires and tubes which upon blowing out do not cause disaster. Various types of sealing compounds, one of which was described in a recent issue of SCIENTIFIC AMERICAN, have been tried—some successfully and some not so successfully. There has also been invented a device which consists of an additional rim to take the weight of the car should the tire go suddenly flat. One such device is described in an accompanying item in this issue.

From the Goodyear Tire and Rubber Company comes information of a radically new type of protection against disaster when the tire itself is ripped. This new idea is incorporated in a tube, the protection consisting of an additional inner fabric



Section of a double tire-tube

tube which normally is inflated with air at a pressure equal to that in the main or outer tube. As shown in the accompanying illustration, there is an easy interchange of air between both tubes through the tiny vent hole near the wheel rim. Should a blowout occur only a portion of the air is lost and the tire drops down only slightly to ride on the inner fabric carcass which loses its air very slowly. This permits the car to continue under perfect control until the driver has time to pull off the road and stop.

Aluminum Production in Sweden

A NEW aluminum factory, the first one in Sweden, has been put in operation at Mansbo, near Avesta. The factory is owned by the Swedish Aluminum Company, a sister company of the Norwegian Aluminum Company, which in turn is closely connected with the Aluminum Company of America. The Mansbo factory is one of the most modern plants in the world for the production of raw aluminum and its alloys. Its production capacity is 1800 metric tons annually, which approximately corresponds to the total present consumption of Sweden. Forty-six large electrolytic furnaces and two smelting furnaces for the casting of ingots of aluminum and alloys have been installed.—*A. E. B.*

Testing Influence of Environment

WITH adopted children to aid them, psychologists are attempting to pin down that elusive problem: Which is more important to a child's intelligence, his heredity or his environment?

The answer appears to be that environment is relatively insignificant.

The elaborate precautions that are being taken to control the experiment, so that the

true influence of environment may be measured, were described before the American Statistical Association, by Dr. Alice M. Leahy of the Institute of Child Welfare, University of Minnesota.

Conflicting reports from previous psychological studies prompted the investigation by the Institute, Dr. Leahy said.

"From the data so far presented, we may conclude that environment has a relatively less significant rôle in the determination of intelligence than heredity."

If further analysis supports the tentative results, then, said Dr. Leahy, "we must conclude that the influence of environment on measured intelligence is relatively insignificant."—*Science Service.*

Prize for Young Biological Chemists

A PRIZE of 1000 dollars and a bronze medal, to be awarded each year to the young man or woman who has done outstanding work in biological chemistry, has been announced by the American Chemical Society. The prize was established by Eli Lilly and Company, manufacturing chemists of Indianapolis, for the purpose of stimulating fundamental research in biological research. Recipients of the prize must be under 31 years of age and will be selected by a committee of eminent biological chemists, appointed by the president of the American Chemical Society.

The first award of the new prize will be made at the meeting of the American Chemical Society in New York during the week of April 22.

The company's interest in biological research is further demonstrated by its newly erected laboratory building. The laboratories are beautifully appointed. The rubber-tiled floors vary in design, so there is no monotony. The walls are of enameled brick, while the wainscoting in the hallways is of travertine. The equipment throughout is modern and adequate, and one research worker remarked that he had never seen so much new equipment at one time in his life. Adjacent is a series of small private rooms available to those engaged in protracted work, while the book stacks, modern in every detail, house a library extraordinarily complete for the special work it is to serve.

The animal quarters are unique in scientific laboratory construction. They are air-conditioned and provided throughout with equipment such that sanitary conditions can be maintained with a minimum of effort.

The staff of the research division includes over 75 chemists, pharmacists, pharmacologists, bacteriologists, and others trained in the medical field. Forty of this number devote their entire time to research problems.—*A. E. B.*

Smoking Mothers

WHEN a mother smokes heavily before the birth of her child, some of the substance in tobacco smoke which makes the heart beat faster is transmitted to the blood of her unborn child and also makes its heart beat faster, Drs. Lester W. Sontag and Robert F. Wallace found in experiments conducted at Antioch College.

In their scientific report to the *American Journal of Obstetrics and Gynecology*, these

Right: **A stock of frogs used for testing various drugs in the Lilly laboratories is kept in the large refrigerator at the right**

Left: **A view of the Lilly pharmacological department. This company is offering a prize to be awarded to a young chemist for outstanding research work in biology**

physicians make no statement concerning harmful effects of maternal smoking upon the unborn child. But taking into consideration the work of other scientists on the effects of nicotine in the milk of smoking mothers, they consider it "not improbable" that maternal smoking before the birth of the child may have permanently harmful effects on the offspring.

A careful study of the newborn children of mothers who smoke heavily before their children are born is, they believe, the next step to be taken in order to reach a scientific conclusion as to whether mothers should or should not smoke while bearing and nursing children.—*Science Service.*

Electro-Deposited Shellac

RECENT experiments in Bangalore, India, reported in *The Chemical Age* (London), show that shellac can be deposited electrically from its solution in alkalies. Apparently the process may be applied either for the purification of shellac, or for its intimate admixture with other materials, including rubber. Electro-deposited shellac is not as soluble as usual in alcohol, but this solubility can be restored by proper treatment with acetic acid. The first attempted practical applications are for the recovery of shellac from scrap and waste on the one hand, and for the direct application of insulation to copper wires on the other. Wires treated with mixtures of shellac and rubber, after a conditioning treatment, are well and strongly insulated, according to *Arthur D. Little's Industrial Bulletin.*—*A. E. B.*

An Aid for Amateur Movie Photographers

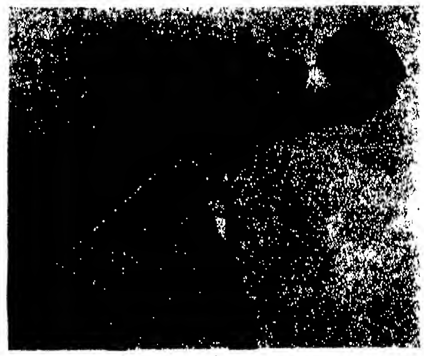
A NEW radial "wipe" device has been designed by Du-Morr Laboratories for use with the Ciné Kodak Special movie camera. This device enables the amateur photographer to secure the same effect that is used in professional photography where one scene is wiped off the screen by the next, thereby avoiding abrupt change from one scene to another.

Bakelite laminated is the main material of construction. The device consists of a ⅛ inch thick laminated base which has a ½ inch lip on one side to provide rigidity and light weight. The base is fastened to the tilting tripod head by screwing the tripod handle through a stainless steel bracket on the underside of the base.

The camera is mounted rigidly on the wiping device by the tripod bolt. A fan, covered with black velvet on the face toward the camera, is mounted in front of the lens and geared so that it can revolve, shutting off the field of the camera at the end of the first scene.

In the actual making of a "wipe," it is necessary to produce several frames on the film, in which each successive frame has a greater portion of the area blocked off, or unexposed. This process of cutting the field of the camera is accomplished by the rotation of the fan in front of the lens. This is made possible by engaging the gear of the wiper with the gear on the camera while it is recording the closing action of a scene. When the fan reaches approximately the upper position the camera and fan are stopped.

At this point the position of the fan is noted on the index scale in the upper right corner of the fan. Next the film is rewound 24 frames with the shutter closed. Then the



A "wipe" device for movie cameras

fan is placed in the same position it occupied at the end of the first scene, and the camera is ready to take the next scene. With the fan in place, and the gears meshed, the camera is started when the action begins. This causes the fan to revolve out of camera range, gradually revealing the second scene, at which time the gears are disengaged, allowing the operator to continue shooting the ensuing action until another "wipe" is desired.

Heavy Water Molecules Act as Tracers

WHEN you take a drink of water, half of it is still in the body after nine days. And the average time a water molecule stays in the body is 13 days. This is the summary of investigations making use of heavy water for physiological studies of the water content of the human body which have been developed by Prof. Georg von Hevesy and E. Hofer of the University of Freiburg in Germany.

Because heavy water molecules can be distinguished by physical tests, although inseparable chemically from ordinary water, they can act as tracers in studying how the body eliminates water by respiration, perspiration, and urination. Previously physiologists have never been able to make exact tests of how long the water in any particular drink stayed in the body.

Half the original quantity of water taken into the body is lost in from eight to ten days. The average time a water molecule spends in the body is from eleven and one half to fourteen and one half days. "To explain this comparatively long time," state Prof. von Hevesy and Mr. Hofer, "we have to assume that most of the water taken becomes completely mixed with the water content of the body."—*Science Service.*

Roughening Steel Floor Plates

SURE footing, necessary in all factories and plants where employees are passing to and fro in the course of their work, is always a highly important factor. The use of plain flat steel plates for truckways, door sills, loading dock toeboards, is general in all practice. Scrap material that would otherwise be junked is often used. Becom-

ing slightly worn, these plates often get a highly polished surface and become very slippery, especially when oily, greasy, wet or under winter or outdoor conditions. These can be roughened up very nicely with the use of the oxy-acetylene blowpipe flame.

Hold the flame on the steel plate in one spot until the spot just melts, then rapidly remove the flame. Do this in as many spots on the plates as necessary to give sufficient roughness. The small indentations with the rough, hard edges of these artificial pit marks, constitute a long wearing roughness of just the right amount to prevent slipping—even when pushing a heavy loaded hand truck. The pit marks might well be spaced about one inch apart in both directions, either in straight rows or alternate rows.

Certain advantages of this method are as follows: a roughened non-slip surface can be created in a few minutes at short notice with small expense; a plate can be treated while in place—one reason for the low cost—or without removing it from service, even temporarily; the surface can be made with any degree of roughness to suit demands or conditions.

Better Resistors for Radio Sets

CONDENSERS, volume controls, and resistors are the most common causes of breakdown in modern radio sets, according to Ralph Sayres, pioneer radio man and president of Lynch Manufacturing Company, resistor specialists. "The fundamental defect in most resistors," he states, "lies in their porosity and may be observed through

Above: **Photomicrograph of an ordinary radio resistor.** ***Below:*** **A new resistance material, at same magnification; fine-grained in structure**

a powerful microscope. Due to their porous texture, most resistors readily absorb moisture, and are therefore sensitive to atmospheric humidity which alters, appreciably, their resistance value. In this porous mass there are countless voids and inclusions, and electrical contact is limited to point-contact only."

A new type of resistor now on the market is said to overcome these troubles, being rock-hard and moisture-repellent. Of a special ceramic composition, extruded under tremendous pressures at what engineers call "dazzling yellow" heat, this new resistance element affords a compact, homogeneous substance that is uniformly conductive, without pores, voids, or their resultant point-contacts.

Green Highballs

HIGHBALLS that turned green as guests sipped them, had the proprietors of a swank hotel on the west coast worried—to say nothing of the consternation of the customers—until a chemist was called in to explain the phenomenon. James H. Collins, of the Arthur R. Maas Chemical Laboratories, recounts this amusing incident in *Chemistry and You.* To make it all the more perplexing, it was found that highballs made from different liquors did the same thing, but that not all of them turned green every time.

The answer was quite simple, although it took a little detective work by the chemist. Good liquor contains tannic acid, which it picks up from the cask in which it is aged. Tannic acid turns green in the presence of iron. The iron was present in some of the ice. The chemist discovered that two or three of the cans used in the ice plant had rusted slightly. If ice from these cans got into the highball, it turned green—otherwise not.—*A. E. B.*

Floor-Fixer

AMOLASTIC is the name of a new product recently put on the market by the Floor Treatment Division of American Oil and Disinfectant Company. It is a fine-grained asphalt emulsion which is mixed with materials such as cement, sand, or gravel, and is used for repairing and resurfacing all types of floors.—*A. E. B.*

Unique New Business Card

PROBABLY 99 business men out of 100 who have any great number of callers, have tucked away in some corner of their desks stacks of business cards. They usually drop these in the drawer with good intentions: they will transfer name, address, and telephone number to their address books later on. Somehow they never quite get around to it.

With a card recently developed the difficulty of keeping addresses of callers is obviated. The face of this business card, which has been given the name "Keep-a-tab," is the same as that of any ordinary card. At the end on a fold-over flap, however, there is printed or engraved the name and address of the salesman or firm and the telephone number. This end or back-flap tab is gummed so the prospect can easily tear it off and insert in the proper alphabetical position in his address book. It has the advantage of small size for insertion even in very small address books, it eliminates the messy drawer of cards that can never be found when wanted, and makes more sure the preservation of salesmen's names and addresses.

This new card was worked out by Mr. V. J. Sawdon and Mr. Kent R. Costikyan,

Advertising Executive of Platt-Forbes Inc. Patents have been applied for and cards are now available either in blank or finished form.

Gasoline Machine Guns

FROM time to time we have had occasion to point out in these columns that the power in gasoline is far greater than that in black powder and other explosives—to be more exact, gasoline has more B.t.u.'s per pound. This explanation has hitherto been necessary to correct the impression of many people that internal combustion engines could be made to operate on gun powder with a resulting increase in power. Now it seems that still another view may be taken of the possibilities of these two explosives.

According to a writer in *Army Ordnance*, gasoline is suggested very often in the daily press as a more efficient propelling force for machine guns. "Last fall," says the writer, "a dispatch from Berlin announced that Europe was astounded with the invention of a Japanese machine gun using centrifugal force to fire 9075 projectiles per minute absolutely silently. Those who were present at the 1920 meeting of the Army Ordnance Association at Aberdeen will recall the demonstration of a similar gun which was operated by a truck motor and discharged 1200 tempered steel bearing balls per minute. However, the range was insufficient.

"Eventually some such device may be perfected. At all events it is of interest to compare the available energy in gasoline with that in gunpowder:

	B.T.U. Per Lb	Work in Kg M
Pure Nitrocellulose	2000	467,500
Black Powder	1230	291,100
Gasoline	20,000	4,760,000

"The only advantage of the powders is that they liberate their energy almost instantaneously, which the far less expensive and more powerful gasoline fails to do."

Nitramon, A Revolutionary New Explosive

A REVOLUTIONARY new blasting material for use in quarries and in other blasting operations such as stripping, cannot be detonated by the strongest commercial blasting cap, by impact, by flame, nor by shooting a rifle bullet into it. In actual use it is exploded by means of a large diameter cartridge of dynamite. It is non-headache-producing and is rendered absolutely water resistant by being sealed up tightly in a tin can. It is stated to represent the ultimate in safety in so far as a blasting agent is concerned. It represents a very radical departure in the explosives field. This new development has been covered by two patents, one for the product itself and the other covering its method of use. It is non-freezing.

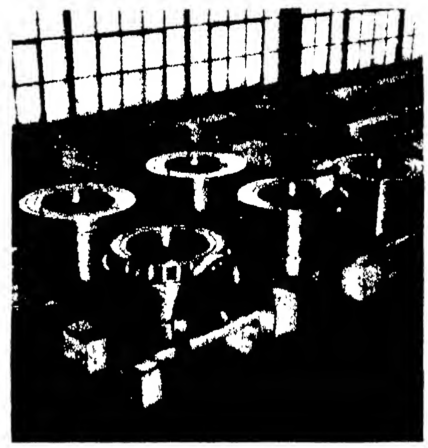
The new product, known as Nitramon, will be marketed only in large diameters, for example, four inch, four and one half inch, five inch, and seven inch. It is adapted solely for use in large diameters and has been designed specifically to fulfill as nearly as possible the ideal qualifications for use in quarries and in coal stripping operations.

The fact that it cannot be detonated by any of the ordinary means used to detonate explosives makes it safe for transportation in a degree hitherto unknown for any blasting agent.

Work on this new explosive has been going on for months. It has been tested both in the duPont laboratories and in the field and by agencies outside the company.—*A. E. B.*

Giant Roller Bearings

JUST a few of the 1400 Timken tapered roller bearings which will be used in the new Ford steel mill are shown in the accompanying photograph, ready for shipment.



Huge roller bearings for steel mill

Fifty-two bearings of the size shown (25½ by 40½ inches), each weighing 4086 pounds apiece, will be installed on the back-up roll-necks of hot strip mills and cold strip mills. The loads on the back-up roll-necks of a single stand reversing cold mill will be carried by four similar bearings.

Eighty-seven different sizes of bearings will go into the equipment now under construction. These bearings vary in weight from one pound for the smallest up to 7640 pounds each for the big ones used on the single stand reversing cold mill.

In all, 185 tons of Timken bearings will be used in the new Ford mills, now being built by The United Engineering and Foundry Company. It is believed that this is the largest single order for steel mill anti-friction bearings ever placed.

Dust from Above

OVER 50,000 tons of meteorite dust are estimated to fall upon the earth daily, according to Prof. H. H. Nininger, secretary of the International Society for Research on Meteorites, curator of meteorites at the Colorado Museum of Natural History, director of the Nininger Laboratory, and owner of the largest private collection of meteorites in the world.

"Through this constant bombardment, the earth is being built up by shattered fragments of previous worlds," Prof. Nininger says. He explains that while a meteor like that observed on March 24, 1933, might leave only a few pounds of solid stones, it also left behind a dust-cloud covering an area of many miles, and from 20 to 60 miles

high. "This cloud was about 1000 cubic miles in volume, and may have contained thousands of tons of star-dust which gradually settled out on the earth."

"Although accurate counts by trained observers have placed the number of meteorites falling into the atmosphere at 20,000,000 daily, meteorites are not easy to find. There are very few men alive who have ever found even one piece of one meteorite."

"One of the greatest difficulties in making an accurate study of meteorites and their fall is that ordinary observers are so mistaken in their idea of distance. People frequently tell me that they narrowly escaped being hit by a meteor which actually never passed within 100 miles of them."

1934 Tornado Toll Below Average

Wedging a dime into a tree trunk and driving a 10-foot plank through the chassis and steel body of an overturned automobile, the outstanding tornado of 1934 lived up to its family reputation for prankishness. Real twisters, however, were comparatively few and far between in the United States last year. Windstorms violent enough to do a great deal of damage swept over the Midwest and parts of the East and South, but they were not of tornado intensity.

Weather Bureau records show that there were only 76 true tornadoes in 1934, as compared with 260 in 1933, and 152 in 1932. The 76 twisters of 1934 cost the lives of 32 people and demolished property valued at nearly 2,800,000 dollars. But the tornado toll of other years has run from 36 lives, in 1931, to 794, in 1925, and from a property loss of nearly 3,000,000 dollars, in 1923, to one of about 43,500,000 dollars in 1927. Since 1916, the records show, only one year, 1919, has had as few twisters as 1934 had. The 65 tornadoes in 1919, however, killed 205 people and destroyed property worth 6,861,000 dollars.

The tornado belt, the Weather Bureau says, is commonly presumed to be Arkansas, Missouri, Iowa, Illinois, and much of Kansas and Nebraska. A tornado, however, may appear in other parts of the country, as was evident last year when New Orleans, Cleveland, and Indianapolis were hit. Nor, the climatologists add, do twisters follow any special plan. Past performance is no key to where or when the next one will strike, or the damage it will do.

CURRENT BULLETIN BRIEFS

Bibliography of the Redwoods. A plea to save the redwoods, one of the priceless heritages of our western states, together with a lengthy list of books, magazine articles, and so on, devoted to this particular type of tree. *Save-the-Redwoods League, 114 Sansome Street, San Francisco, Calif.—Gratis.*

Vocational Teacher Training in the Industrial Field. Four reports of the Committee on Trade and Industrial Teacher Training of the American Vocational Association, Inc., stressing the importance of an adequate staff of trained teachers for the successful operation of a program of publicly supported vocational education. Vocational Education Bulletin No. 172. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

Safeguarding Electric Service in the Home. The wiring of electric lights and other electrically operated devices in the home is often taken too much for granted. This booklet and inserted material stresses some of the points that should be watched. *Write for Bulletin 435-A, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

The United States Coast and Geodetic Survey. A summary of the work of this body in surveying and charting the waters of the United States, and also of its other activities. Of particular importance to both motorists and those who use boats of any type. *United States Government Printing Office, Washington, D. C. Gratis.*

Vital Impurities. The importance of certain impurities in Chilean nitrate fertilizers. *Write for Bulletin 435-B, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

Farm Property Improvement outlines the adaptation of the Better Housing Program to farm conditions, pointing out how this plan makes possible needed farm improvement work. *Federal Housing Administration, Washington, D. C. Gratis.*

Pioneer Wind Tunnels, by N. H. Randers-Pehrson, is a description with illustrations of some of the original wind tunnels used for determining aerodynamical properties. *Publication 3294. Smithsonian Institution, Washington, D. C.—20 cents.*

Dark Field Optical Systems. A practical discussion of the subject, together with illustrations and prices of equipment necessary for the work. *Write for Bulletin 435-C, Scientific American, 24 West 40th Street, New York City—3 cent stamp.*

Electrical Grounds on Water Pipes, by H. S. Warren. Grounding electrical circuits on pipes often is detrimental to the piping. This is a discussion of the types of grounds employed, their purpose, and the probable effects on water piping systems. Monograph B-821. *Bell Telephone Laboratories, 463 West Street, New York City.—Gratis.*

The Sperry Pilot for Automatic Flying. Complete descriptions with excellent drawings of this gyroscopically operated automatic pilot, telling how it operates, how it is used, and its advantages. *Write for Bulletin 435-D, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

Teaching Farm Credit. It is essential that every farm be operated under a systematic financial program. This 44-page pamphlet tells how such a program may be arranged. Vocational Education Bulletin No. 178. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

THERE'S LIFE IN THE OLD IRON HORSE!

(*Continued from page* 181)

tific knowledge. But, at that, they will not exhaust the speed possibilities of steam.

The steam unit—the new rather than the old iron horse—is not, for all these reasons and others that might be suggested, done for. There's life in her yet! Indeed, I feel I may venture the thought that, far from being done for, the steam unit may take the challenge of the oil-electric as it took the challenge of electricity, in its stride, as it were, and continue to rule the rails—at least the main-line rails.

In switching service, where a 100-ton unit is adequate, the oil-electric is without question here to stay. In branch-line work, where there are now more than a thousand Dieselized and other internal-combustion rail cars in service, it has a definite function up to a certain point. In many instances it has already eliminated the spectacle of old main-line passenger locomotives, some with boosters and in some cases even freight locomotives of 2500 or 3000 horsepower, being used to haul trains of two or three cars. Therefore it is wholly possible that in due course light steam units, new in kind, may appear to compete successfully with oil-electrics, even in branch-line work.

In any case, those of us who are directly associated with American railroading have at least three things to be thankful for:

First: We have three power units, instead of two, to work with.

Second: Without question we are entering upon an era certain to be characterized by extensive replacements as distinguished from repair, notably of passenger power units and passenger equipment, to the end that our roads can regain lost passenger traffic by providing the fastest, safest, most comfortable overland transportation.

Third: In this picture there is opportunity for science to make its third major contribution to railroading by applying, although tardily, its many accumulated findings to the generality of steam locomotives.

The stage is ready.

During the last 15 or 20 years locomotive steam pressures have been advanced from around 200 pounds to as high as 850. Every part of the unit has come in for redesign or other improvement, with the result that the service thermal efficiency of new units is approximately double that of those built 20 years ago. Meanwhile, runs between division points have been increased from 100 or 150 miles to 500, 600, 700, even above 800 miles, and the mileage covered between overhaulings has been increased around 10 times, so that today many passenger locomotives go 300,000 miles without a general shopping.

Accordingly, though I repeat that we are equipped, and it is our job, to give our customers whichever power unit is for them most economic, all things considered, I judge that the steam locomotive is a long way from done for; may well increase the respect and affection railroad men have for it; will gain, rather than lose, from the competition of the new main-line unit, the oil-electric.

THE SANITY OF INSANITY, OR THE INSANITY OF SANITY

(*Continued from page* 190)

song" of his life—and we can call to mind just such cases from our own acquaintance. So the school was wrong and he said so—said so very loudly, in fact. He started a little laboratory in the barn and suddenly discovered his grand elixir of life, the medicine that would cure anything. He put in on the market—and nothing happened.

That needed explanation. Ha! He had it! The medical profession was persecuting him. His great discovery would put all doctors out of work. It was a conspiracy. So he wrote the head of the American Medical Association, giving him fair warning to "lay off." Nothing happened. Another letter brought no result. He wrote President Hoover. Still no result. So one day, goaded to exasperation he took a gun, called on the nearest doctor and shot him. Moreover, he'll tell you he was quite justified in doing so. Furthermore, if you accept his original "theme song," he was. But note that all through it he was merely pursuing the pleasure principle. His greatest pleasure came from his own feeling of superiority. As the object of a plot by the combined medical forces of the entire country he really feels important. He believes it and is happy.

So the story goes. Here is "Britannia, the Pride of the Ocean." She is there because of persecution by an American admiral. Another has a wonderful scheme of supplying New York City with ice in the summer: a system of chutes will bring a glacier down from Greenland to Times Square. Of course this would ruin the New York ice companies, so they have had him confined in an asylum. One chap sits in the corner and grins all day long. Another raves at the top of his voice that he is John the Baptist preaching in the wilderness. Both are having a perfectly wonderful time. We might continue these cases by the dozen, but would always find the same story.

Each of us has a theme of life. We can define it psychologically in terms of the pleasure principle. Some seek wealth, some fame, some power.

But the insane have solved life's problem. They have accepted at its face value Christ's dictum "The Kingdom of God is within you." You wish wealth—they have it. You seek for power but this chap *is* Napoleon. You laugh and say he's insane. But what are *you* seeking? Happiness! Have you found it? Only partially, at best, and you may be very unhappy. He is so pleased with himself that in a great many cases he won't even waste time talking to you. You, my friend, in his opinion, are a mere worm and a very foolish worm at that.

He is incurable because he doesn't want to be cured. After all, is he not very wise? You toil, you strive, you worry and as like as not you end your life in comparative poverty. He never works, he's well fed and worry never crosses his path. He dies a multi-millionaire. Well may he look at you and say, "Poor devil, he's sane."

Books SELECTED BY THE EDITORS

(*Continued from page* 172)
of following its guidance is greatly improved health. SCIENTIFIC AMERICAN articles have shown the close relationship between poor posture—sitting, standing, moving—and poor health. As the posture is corrected, there is improvement physically and mentally. This volume will, therefore, be surreptitiously borrowed from the wives of many tired business men and read by said T.B.M. for efficiency's sake. Children should be encouraged to read it. —$1.90 postpaid.—*F. D. M.*

RADIO ROUND THE WORLD

By A. W. Haslett

A SURVEY of present-day radio including a chapter which gives the necessary historical background. There is a simplified discussion of the Heaviside layer, the effect of the sun on radio transmission, and other phases of radio phenomena which often are puzzling to the layman. 196 pages, illustrated with drawings and photographs.—$1.90 postpaid.—*A. P. P.*

CLINICAL AND PATHOLOGICAL APPLICATIONS OF SPECTRUM ANALYSIS

By Dr. Walther Gerlach and Dr. Werner Gerlach

THERE is no general semi-popular treatise on spectrum analysis in the English language (as there should be) but this 130-page book is a very practical and not highly technical treatise on one of the many special aspects of this subject. To the reader who comprehends physical optics and is familiar with laboratory apparatus, it tells how to set up and use light sources, take spectrograms, and make spectral analysis of biological samples—organs, secreta, excreta; how to apply spectrum analysis in electropathology, in shot wounds and on bullets (detective work); also its use in examining for traces of various elements. It is a translation from the German and is a practical rather than a theoretical book, covering a wide variety of applications within the single field mentioned.—$4.50 postpaid.—*A. G. I.*

MARVELS OF MODERN CHEMISTRY

By Beverly L. Clarke Ph.D.

MORE and more it becomes apparent even to the most casual observer that the science of chemistry has a very definite effect on our everyday lives. In this book the author has attempted to make a general survey of all phases of chemistry—a stupendous undertaking—and to explain them clearly and simply for those who may have forgotten all of the chemistry they ever learned. The result is a book that is entirely understandable. In a few places chemistry symbols are used where it is unavoidable but certainly not to an extent which might deter the average reader. 374 pages, illustrated, with a comprehensive bibliography and index.—$2.65 postpaid.—*A. P. P.*

BEFORE THE DAWN OF HISTORY

By Charles R. Knight

THIS book consists of a collection of large reproductions (the format is 9 by 12) of the author's large and famous mural paintings of prehistoric animals permanently hung on the walls of the American Museum of Natural History, New York, and the Field Museum of Natural History, Chicago—paintings of giant dinosaurs and primitive extinct mammals: uintatheres, titanotheres, creodonts, glyptodonts, and so on. In his qualification to write this book and paint these pictures in their proper environmental settings, the author is practically unique, for he may be looked at both as an artist who understands the scientific aspects of his subjects and as a scientist who can paint. His paintings are as nearly authentic as it is possible for science to make them. Opposite each painting there is a scientific interpretation. The author also explains how he builds up these pictures, after much painstaking research. —$2.65 postpaid.—*A. G. I.*

DIESEL HAND BOOK

By Julius Rosbloom

A GREATLY enlarged second edition of a work that has been standard for several years. It is a practical book of instruction for engineers and students, on modern Diesel engineering—land, marine, locomotive, air, automotive, and portable installations. Profusely illustrated, 543 pages.—$5.25 postpaid.—*F. D. M.*

THROUGH SPACE AND TIME

By Sir James Jeans

SIR JAMES JEANS' latest piece of popular writing is very popular indeed, containing eight lectures which he recently delivered to audiences made up of persons from eight to eighty years of age. Its chapters deal respectively with the earth, the air, the sky, the moon, the planets, the sun, the stars, and the nebulae, and make very easy, informative reading.—$3.20 postpaid.—*A. G. I.*

THE MODELMAKER—Volume XI

Edited by W. Edmonds Spon

FOR those interested in the hobby of making working models, this 315-page book will prove interesting and useful. Details, instructions, plans for making an amazing variety of models that work: Airplanes, locomotives, boats, railway systems, and pumps and other machinery. Gossip of the hobbyists, also.—$2.40 postpaid.—*F. D. M.*

HISTORY OF MAGIC AND EXPERIMENTAL SCIENCE

By Lynn Thorndyke, Prof. Hist., Columbia Univ.

THIS is a lengthy work of two volumes, with a total of 1259 pages exclusive of appendices and index, and it is a continuation of two volumes covering earlier centuries of history, published by the same author in 1923. It is scholarly and exhaustive and its purpose is to provide background for the student who wishes to obtain more than a superficial insight into the historic origins of early and evolving science. By "magic" the author does not mean sleight of hand tricks, which is only a special, modern usage of that word, but a mass of ideas or doctrine representing an early way of looking at the world. From our modern point of view it is easy to separate the sciences of astronomy and chemistry from the superstitions of astrology and alchemy—these distinctions nowadays seem self-evident except to thousands of the uncritical whose mental outlook is medieval. Centuries ago the two were one entity; was not the court astrologer Kepler also a great astronomer? But it was the early magicians—astrologers, alchemists, and others—who were the first to experiment, and modern science with its experimental method evolved out of these early efforts. It is impossible to comprehend the significance of modern science in the world without studying the history of science, and this learned work will greatly enlarge the point of view of the student of that subject.—$10.50 postpaid.—*A. G. I.*

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SCIENTIFIC AMERICAN

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

CONTENTS · MAY · 1935

The SCIENTIFIC AMERICAN DIGEST

Of General Interest

Chemistry in Industry

Aviation

Health Science

NRA CODE

COVER

THE transport plane of United Air Lines, viewed from an unusual angle, is truly symbolical of progress and power in the air transport field.

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ACROSS THE EDITOR'S DESK

AS this issue was going to press, newspaper headlines went wild with news of war rumors in Europe. Germany is Arming—Huge German Air Forces—Gigantic German Bombing Fleet—they screamed, to the mental discomfiture of peace-loving people. In probably no other field do rumors attain such seemingly authentic status as in propaganda, and the present situation is a case in point. *Perhaps* Germany has some bombing planes. *Perhaps* her air force is great and powerful. *Perhaps* she can place in the field a large number of highly trained pilots. But Igor Sikorsky, widely known aviation expert, recently made an exhaustive study of aeronautical conditions in Germany, and he holds other views. He admits the possibility, in the article "Wings of Europe," page 229 of this issue, of secret sources of aircraft supply in Germany, but he deprecates the high rating that has been given to such activity by outside sources. The bogey of German air strength still remains, at the time of writing, just a bogey, and spectacular displays of a handful of planes do not prove the existence of a powerful air arm. Every peace-seeking person will watch the disclosure of the truth with interest.

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SORRY, but the article by J. Reid Moir, "Did Man Exist in the Miocene Epoch?" promised for this month, had to be held over. We will try to include it in the June number.

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JUST what is "heavy water;" what are its implications in the realms of pure and applied science? The subject of heavy water has been discussed briefly in past issues of SCIENTIFIC AMERICAN, but next month we shall present the full story, as prepared by Dr. Harold C. Urey, discoverer of heavy water and winner of the Nobel Prize in chemistry, 1934. An example of the facts disclosed by Dr. Urey is given in the following quotation from his article: "The biological interest of the heavy water can hardly be over-emphasized, since all living beings live essentially in a water solution. . . . It is my expectation that both animals and plants can be acclimated to high concentrations of heavy water, but that probably their living processes will be much slower."

COMING

- "Heavy Water," by Dr. Harold C. Urey.
- Industry in the South, by Secretary of Commerce Daniel C. Roper.
- "All-Wave Receivers," by M. L. Muhleman.
- Spanning the Mississippi at New Orleans, by Harry J. Engel.
- The Future of the Diesel in Railroading, by George W. Codrington.

●

"THE South, with slightly more than 30 percent of the nation's population, now employs about 20 percent of the entire country's factory workers. . . . As compared with the late 'seventies, when the Southern States accounted for about 33 percent of the population and only 11 percent of the wage earners in manufactures, this betokens a noteworthy degree of progress in industrialization. . . ." Thus writes Secretary of Commerce Daniel C. Roper, in an article on the industrialization of the South, scheduled for publication next month. Scientific research has done much to assist this industrialization, and Secretary Roper traces the development in terms that give a complete survey of the entire situation. His article is as informative as it is authoritative.

THE city of New Orleans has long been in need of adequate bridge facilities that will enable traffic to move to and from the city without loss of time in ferry crossings. Plans for such a bridge have been completed, and work is well underway. An article to be published soon will give the details of the construction work, as well as a background of the economic significance of this important traffic link.

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YOU, as a reader of SCIENTIFIC AMERICAN, play a tremendously important part in the editorial make-up of the magazine. Your letters serve as a guide to the editor, showing him the type of material that is most desired. Increasingly large numbers of requests for radio information have resulted in the preparation of a series of radio articles, the first of which appears on page 232 of this issue. Next month M. L. Muhleman will write on the subject of "All-Wave Receivers," from the standpoint of the reader who wants to listen-in on foreign broadcast programs.

●

THE third and last of our series of articles on railroading, its present status and future possibilities, will appear next month. This article, prepared for us by George W. Codrington, President of the Winton Engine Corporation, takes up the question of the Diesel engine and its application to railroading problems. Where the Diesel-engined train fits into the picture of rail transportation is a question that has often been discussed as a result of the many Diesel-powered units which have been produced in past months. Our articles on steam (last month), electrification (this month), and Mr. Codrington's (next month), give the reader complete coverage of the situation.

Orson D. Munn
Editor and Publisher

Books SELECTED BY THE EDITORS

UNROLLING THE MAP. THE STORY OF EXPLORATION

By Leonard Outhwaite

THERE is romance in this book. Its 340 large-sized pages, and its numerous maps, tell the complete story of world exploration. In a systematic manner the author takes up in chronological sequence the explorations of each of the world's noted explorers, not merely in our age but right down through all history, and presents an account of the accomplishments of each. The reader thus sees the world map, at first mostly black, grow white or very nearly white, step by step. It is a solid book, either for reading or reference, and the style is both readable and scholarly. This reviewer once attempted to read *all* the books on exploration—a vain ambition which had to be relinquished because a man seldom lives to be more than 1000 years old. But, in "Unrolling the Map," the whole thing is presented within the two blue covers of a single fascinating volume.—$3.95 postpaid.—*A. G. I.*

ANGLING SUCCESS

By Leading Outdoor Writers
Edited by Mortimer Norton

BY obtaining his contributions from various prominent outdoor writers, who are well known as specialists in certain phases of angling, the editor of this volume is able to present a compilation which gives the reader the cream of fishing knowledge. The principal fresh water game fish, from "sunnies" to "muskies," are dealt with in 16 chapters. The articles are all original, not having appeared before in any publication. Each author gives, from his practical knowledge, tips on tackle, and obscure little kinks which are difficult to find elsewhere, but all of which contribute to ultimate success. Illustrated with many photographs.—$2.65 postpaid.—*A. P. P.*

IDENTIFICATION OF FIREARMS

By Jack D. Gunther and Charles O. Gunther

HERE is an honest effort to put on a scientific basis the identification of firearms from ammunition fired therein, usually referred to as the study of ballistics. The authors discuss in logical sequence the principles of firearm identification and include a short yet comprehensive survey of the explosive substances used in firearms to propel the projectile. They then carry on through various types of cartridges and the rifling of barrels. Then is given a résumé of the methods employed by experts in recovering bullets, analyzing the "signatures" and establishing the relationship between ammunition and gun. A large part of the book is devoted to the presentation of testimony at various trials where firearm identification has figured prominently. While the book was prepared more especially for the scientist and the lawyer, it will be of interest to the average reader because of the sociological problems involved and the inherent interest in them. 342 pages, printed on fine coated stock and lavishly illustrated.—$4.20 postpaid.—*A. P. P.*

THE POPULAR PRACTICE OF FRAUD

By T. Swann Harding

MAINLY this book is filled with exposures of fake foods and drugs, and some of its chapter heads—such as "Hell-Fire Advertising," "Sucker-Trapping by Mail," and "Irresistible Charm in Bottles and Jars"—will serve to give a good idea about the content. On the other hand, this is not a typical crusader's work, for it avoids lambasting everything in sight, in the manner of the professional "crusader's" instinct which some think is to lambast mainly in order to be sensational, and to scare 100,000,000 of us almost to death. There is plenty that deserves lambasting without resorting to that method, which is admittedly successful but not very intelligent. Mr. Harding's potent paddle paddles plenty of persons and patent medicines but, withal, sanely. In 376 pages he covers a lot of territory, in an easy running, readable style. This book strikes a rational norm between total acceptance and total rejection of every food and drug.—$2.70 postpaid.—*A. G. I.*

NEW PATHWAYS IN SCIENCE

By Sir Arthur Eddington

EDDINGTON'S new book is altogether up to the standard of his former ones, which are all famous—*Stars and Atoms* (1927), *The Nature of the Physical World* (1928) and *Science and the Unseen World* (1929)—and is the first real Eddington book in six years (*The Expanding Universe*, 1933, was only a minor note). The new book contains six chapters of a physical and philosophical nature: Science and Experience; Dramatis Personae; The End of the World; The Decline of Determinism (law of causality); Indeterminacy and the Quantum Theory; Probability. Following this are several others which deal more directly with objective astronomy: The Constitution of the Stars; Subatomic Energy; Cosmic Clouds and Nebulae; The Expanding Universe; The Constants of Nature; The Theory of Groups. In a final chapter, Criticisms and Controversies, Eddington replies how well the reader must judge—to some who have accused him of warping scientific evidence to suit religious ends. The chapters represent the transcript of a series of lectures recently delivered at

(*Please turn to page 279*)

Science Service photo

THE BITING BLACK WIDOW AND HER BADLY BUILT WEB

AN article about the black widow spider, in last October's SCIENTIFIC AMERICAN, was the forerunner of numerous newspaper warnings and items about its highly poisonous bite. Dr. Fred D'Amour of the University of Denver, Colorado, has since then perfected a serum which has proved successful in treating victims of this dangerous arachnid. As shown in the photograph above, the black widow's web is unmistakably characteristic, being entirely without pattern, a loose shapeless structure of very coarse strands which crackle noticeably when torn

Photo courtesy *Aero Digest*

A general view of part of the successful Paris Air Show

WINGS OF EUROPE

American Air Supremacy Threatened . . . The Bogey of German Air Strength . . . War Aspects of Aeronautics . . . Research Must Carry on

By IGOR SIKORSKY
Vice President, Sikorsky Aircraft Corporation

THE main conclusion that the writer has drawn from an air tour of Europe is that American aviation is definitely superior to European aviation, although faced with a real danger of rapidly losing its lead. For a complete study of European aeronautics it would of course be necessary to spend many months in the chief centers of aviation activity on that continent. There are, however, many advantages in a rapid survey; impressions are then sharpest and clearest. In the following paragraphs the writer gives such impressions as were gained from a flight of approximately 4000 miles over the airways of Europe, including visits to the most important aeronautical centers. These impressions may serve to give the reader a broad, general picture of the present situation in aviation. Because of the vast amount of material from which these impressions are drawn, some of the descriptions will necessarily be superficial.

If the French press is to be believed, Germany now has a potential air force at least equal to that of France itself. Glib statements are made regarding immense German activity, telling of innumerable commercial transports which can be transformed quickly into efficient bombers. The impression of the writer is to the contrary. It is my opinion that the only airplanes of any size being built in Germany are the Junkers three-engined transports. These ships, although excellent in themselves, do not attain anything like the performance of American aircraft. Furthermore, comparatively few of these Junkers are being built.

IT is possible of course that there are secret sources of aircraft supply in Germany, but it would appear, nevertheless, that aviation activity in that country is considerably over-rated. One really fast aircraft—fast according to American standards—is the Heinkel seven passenger transport, a low wing monoplane of very clean design. The Heinkel has a somewhat high landing speed for a small single-engined plane, but it has many desirable features, including complete retraction of the landing gear.

Among the three-motored Junkers transports of Lüft Hansa, a large number are equipped with American-made Pratt and Whitney Hornet engines. On the other hand, however, German designers have achieved one development which is as yet unmatched in any other part of the world. Successful installation has been made on a Junkers transport of an aircraft Diesel engine. This ship is in actual service using heavy fuel oil which increases the economy of operation and reduces the hazards of fire.

One of the fine German institutions, which has led the way in aerodynamic

research for perhaps 20 years, is Göttingen University. At present the Göttingen Aerodynamic Research Institute is functioning smoothly in the realm of pure science. The aerodynamic laboratories and wind tunnels are active and apparently well organized, although the equipment is modest in size when compared with the excellent equipment of leading American research institutions.

One of the striking developments at Göttingen is that of a remarkable high-speed electric motor suitable for use in small models employed in wind tunnel testing. This motor, with an outside diameter of only two inches, is capable of developing over two horsepower. With this small power plant it is possible to "fly" four foot airplane models in the wind tunnel with the propellers of a three-engined ship accurately represented and functioning in correct simulation of actual flying conditions. It is interesting to note that the patient research work which has been conducted at Göttingen, using this newly developed motor, is in gratifying agreement with other work that has been done in the full-scale tunnel at Langley Field in this country.

Photo courtesy *Aero Digest*

An American-made Boeing 281 transport, Pratt and Whitney powered, used by Deutsch Lüft Hansa, photographed at Templehof Aerodrome, Berlin

AMONG other research equipment at Göttingen is a special water tunnel. Paradoxical as it may seem, it has been found that the simplest way to study air flow is to study the flow of water around hydrodynamic or aerodynamic bodies. In the water tunnel, water circulates under the action of a propeller in a fashion very similar to the circulation of air in a wind tunnel. A large tank forms a part of the circulating system. This tank is closed at the top and connected to a suction pump so that experiments can be made with water at practically no atmospheric pressure. By varying the air pressure in the top of this tank it is possible to study the phenomena of the stall of the wing, the breaking down of the boundary layer, and other similar subjects which still remain somewhat of a mystery. This water tunnel opens up entirely new lines of research.

When the writer visited the Air Show in Paris, he was most forcefully impressed by the realistic panorama of a bomb attack on Paris which was on exhibition. Hardly anything could be more convincing of the terrible effectiveness of modern warfare with high-speed bombers carrying several tons of bombs, than this panorama which had been worked out with great technical fidelity. The city streets of Paris were shown, with the population equipped with gas masks and the gas shelters crowded. It appears that all of Europe is thoroughly cognizant of this aerial danger. A sales leaflet handed to visitors at the Air Show, advertising gas masks, brought the point home better than columns of newspaper reports could have done. The bombing operations during the World War were child's play when compared with what is technically possible today. Undoubtedly it is the realization of the scope of aerial warfare which has caused European governments to be extremely generous to all forms of aeronautical development.

There is no doubt that the French Government now realizes fully the extreme importance of aviation for national safety and progress. This is particularly evidenced by the fact that the Government is offering several very valuable aircraft prizes. For example, there is a prize of approximately 660,000 dollars for a French built plane powered with a French Diesel engine which shall set a new long distance flight record.

The only prize of any substantial value which was ever offered in the United States for aeronautical development was the Daniel Guggenheim Safe Aircraft Prize of 100,000 dollars. At the present time, when the officers of our air forces are being condemned for buying the best planes they know how to procure without following unwieldy regulations to the letter of the law, and when the Government is spending so much money for a variety of purposes, would not prizes of similar magnitude to stimulate American aviation be entirely appropriate? One can readily imagine what such prize offers for technical achievement would do for inventors and engineers. The whole art of aviation would thus be stimulated: airplane manufacturers would be able to undertake experimental projects which business considerations would otherwise preclude.

AS was mentioned previously, a perfectly dispassionate view of the entire situation shows that American aviation is in every way superior in the art, when compared with foreign countries. No boasting is contained in the statement that America has the best planes, the fastest and most efficient transport airlines, the best engines and propellers, and superior navigation instruments. The writer, in his survey of the Paris Air Show and of some of the best known aircraft factories in France, England, Germany, and other countries, was not able to find a single essential line of endeavor in which Europe surpassed America. Minor exceptions to this statement might be noted. For example, European-built bombers are noteworthy in offering universal gun fire range with nests of machine guns located at various points, giving real ability to fight off attacking planes. Some gun turrets were seen that were particularly ingenious.

The Heinkel seven-place high-speed air transport of Lüft Hansa

However superior America may be in the aircraft field, that superiority may be short lived. Although American airplane factories have splendid production facilities and excellent engineers, their potential resources are utilized only to a fraction of their capacity. The contrast in Europe is striking. There are located large factories with great forces of men working on large production orders for military and naval aircraft.

AT a time when the United States is actually diminishing its financial support of the aviation industry, European countries are all expanding their programs. Great Britain is planning to increase the speed of its comparatively slow but comfortable Imperial airliners, and to extend its scheduled services all the way to Australia. During 1934 the British Government directly subsidized the Imperial Airways to the extent of approximately 25,000,000 dollars.

France is following the same line of development and is offering a subsidy of 12,600,000 dollars for the operation of its 19,000 miles of airways. The French Air Ministry has spent 5,000,000 dollars for the construction of large flying boats and land planes which are now undergoing tests on the France to South America run. Italy and Holland are taking similar steps to promote their own commercial airlines.

Although the Bureau of Air Mail of the Interstate Commerce Commission is advocating the revision of airmail rates, so as actually to prevent the destruction of American aviation, it is extraordinary to note that, while America is considered the land of wealth and high prices, foreign governments pay much more for aircraft and secure much less for a given sum than is the case in the United States. For example, the Henry Potez Company was paid 430,000 dollars for the construction of a single four-engined transport ship. Although labor in France receives only approximately 60 percent of the wages paid to American laborers, prices for an airplane of a given horsepower and carrying capacity in France are in many cases much higher than in America.

The present superiority of American aircraft is frankly realized by European operators. In Switzerland are being used American-made Lockheed transports. Fokker, the well known Dutch constructor, is building Douglas transports under American license. Douglas transports are also in use on German lines. In the two-motored Fulgur, built to carry 12 to 14 passengers and equipped with two Gnome-Rhone 800 horsepower engines, the Boeing and Douglas influence on the design is clearly apparent. These facts make it desirable to emphasize again that, while American superiority cannot be denied at this time, it is a foregone conclusion that if the present generosity of foreign governments continues and the over cautious policy of the American Government likewise continues, superiority in aeronautics will sooner or later pass across the Atlantic.

After the writer flew from London to Paris he had the opportunity to travel by air from Brindisi, Italy, by Imperial Airways, to Athens in Greece and then to Egypt. Even in winter the Mediterranean Sea is calmer than the Caribbean, and aerial passengers on the Mediterranean flight have an easier crossing than is the case on the North-to-South American line. The general impression which the writer carried away with him of Imperial Airways is that it is a reasonably comfortable travel medium and with good food served on board, but with a cruising air speed of not more than 100 miles an hour.

AS a result of the before-mentioned study of the Paris Air Show, the visits to European centers of aviation and lectures before the Royal Astronomical Society in London and the Société Francaise de Navigation Aerienne in Paris, as well as upon other occasions, the writer made contact with many of the best informed aviation men in Europe.

The strongest impression which he carried away with him was that, while the excellence of American aviation is everywhere recognized, yet in the leading countries of Europe a great effort is being made, well assisted by the various governments, to promote progress in aviation. Therefore, this country can expect to maintain its leadership in aviation only if progressive engineering work properly assisted by the Government is continued without interruption.

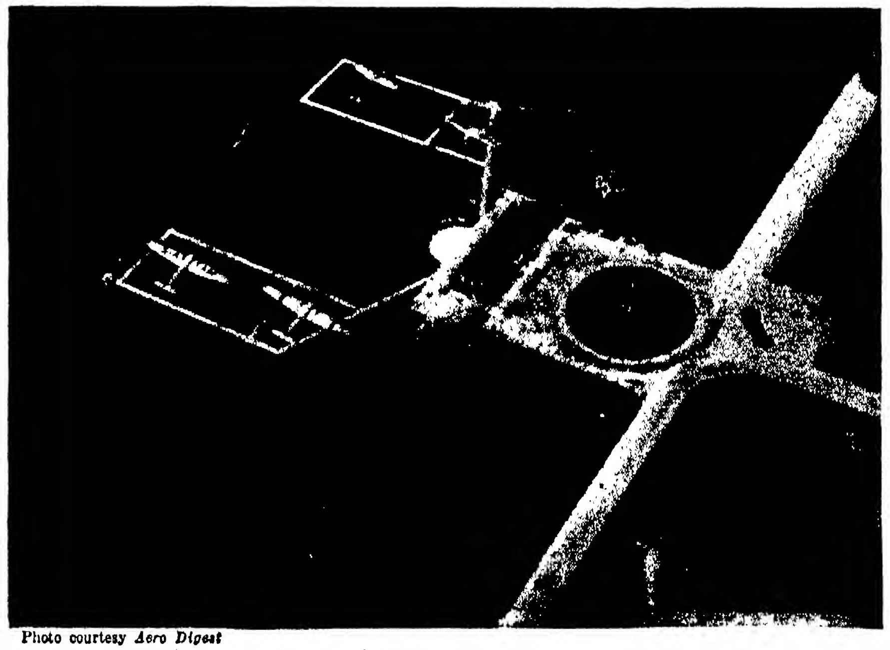


Photo courtesy *Aero Digest*

An unusual view of the airport at Rohrbach, Germany

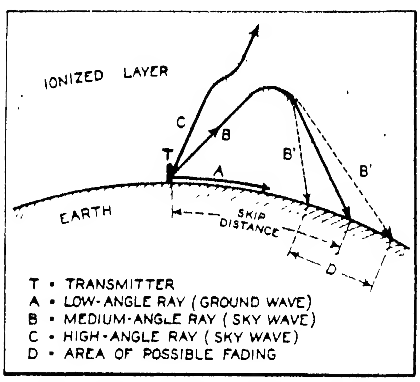
WORLD-WIDE RADIO

INTERNATIONAL BROADCASTING

Why Long-Distance Transmission is Possible With Low Power . . . Day and Night Wavebands

By M. L. MUHLEMAN*

IN losing his rights to the "choice" wavelengths, the American radio amateur some years ago made an important discovery which has since been instrumental in the development of the vast radio communication and broadcast network occupying the wavelengths from 7 to 190 meters. Forced to confine his activities to wavelengths below 200 meters, it was soon learned that these short wavelengths, considered for years to be worthless, were, as a matter of fact, the very best for communication over great distances. For some peculiar reason, these short radio waves did not seem to diminish in intensity. Low-powered signals transmitted from New York were being picked up in Australia with unbelievable volume.



The action of the reflecting layer

Later it was determined that a radio wave embraces two components; a ground wave, which travels but a short distance along the surface of the earth, and a sky wave, more complex than the ground wave, which is radiated upwards. Further than this, it was learned that there exists in the upper atmosphere a layer of electrical particles (the Kennelly-Heaviside layer) from which the radio sky waves are reflected back to earth.

Research brought forth the additional point that the shorter the length of the radio wave, the greater its powers of penetration into the layer. It immediately became apparent that the long-wave signals were reflected back to earth from near the surface of the ionized layer in the upper atmosphere, whereas the short-wave signals penetrated the layer for some distance before being sufficiently bent to return to earth. In consequence, the long-wave signal returns to earth some 50 or 100 miles from the transmitter while the short-wave signal, whose angle of refraction is less abrupt, does not return to earth again for some 500 to 6000 miles or more.

It should be apparent from this explanation that there are areas along the surface of the earth where the signal does not appear, which is true. The effect is referred to as "skip distance." The situation is not quite so bad as it sounds since, aside from the reflection and refraction of the waves from the ionized layer, there is also present a considerable amount of diffusion. Nevertheless, this serves to explain why a listener in New York may have difficulty in receiving short-wave signals from Pittsburgh but experience no difficulty whatsoever in intercepting short-wave signals from England.

THIS short-wave communication and broadcasting by "wave refraction" permits stations to cover huge distances with low power, but the means suffers from numerous forms of instability. For one thing, the ionized layer is in constant movement. This alters the reflection of the signal with the result that at one moment it may be focused directly upon a certain receiving area and the next moment have its center of focus some miles away. This is one of the causes of signal fading.

Another form of instability results from the fact that the layer in the upper atmosphere is ionized by the rays of the sun. As darkness falls, the ionization is reduced with the result that a short-wave signal penetrates the layer for greater distances before it is refracted. Therefore, international short-wave broadcast stations use different wavelengths for different times of the day and night.

During daylight, when the reflecting layer is highly ionized, a very short wavelength will provide the longest skip distance, whereas a longer wavelength would return to earth but a short distance from the station. At night, when the layer is less highly ionized, the very short wavelength will either penetrate the layer altogether, or penetrate it for such a distance that the refracted signal strikes a course parallel to the earth. In either case, the signal never returns to earth. Thus, refraction is dependent not only upon the wavelength of the transmitted signal, but also upon the degree of ionization of the refracting layer. Therefore the longer waves, with less power of penetration, are used after dark and, by virtue of the thinning out of the reflecting layer, provide a skip distance about equal to that obtained with a shorter wave during the daytime.

Generally the international broadcasters use 19 or 25 meters during the day, 25 or 31 meters at twilight, and 31 or 49 meters after dark. These short-wave broadcast bands are well established and the 100 or more stations of the world are to be found at, or near, these points on the dial of an all-wave receiver.

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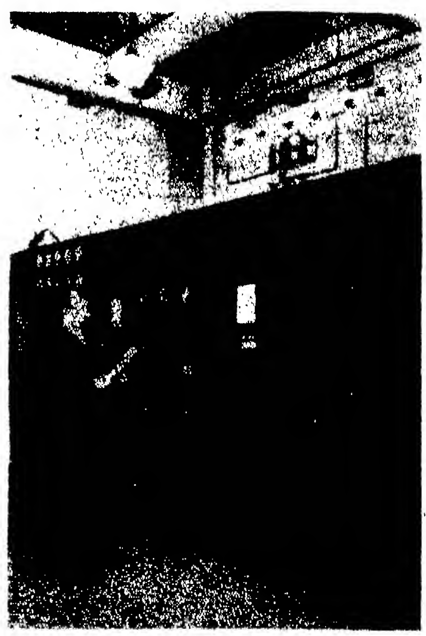
A list of selected short-wave broadcasting stations of the world, giving wavelength, schedule of transmission, and so on, will be sent to readers upon request. Please enclose a three cent stamp to cover mailing.—The Editor.



W2XAF, Schenectady, New York. Antenna wave-change switch at top

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

OUR POINT OF VIEW

Shipping Subsidies

FOR several years, foreign shipping interests, lobbying for state subsidies to help them compete with other shipping nations, have pointed to the American Merchant Marine Act of 1928 and to our system of mail contracts to support their pleas. Unmindful of the fact that America builds but a minute fraction of the shipping tonnage the world builds, as we pointed out editorially last month, they have called our system a state subsidy and have expressed fear of the competition from a renascent American Merchant Marine. We, in turn, have denied the subsidy accusation with many fine phrases, yet have hoped they were right in their fears. We denied subsidizing our shipping and on the other hand hoped that our Government aid *would* rebuild our merchant fleet. We simply did not face facts.

It has remained for the President to bring the whole subject frankly into the open. Our present system *is* a subsidy but far from an effective one. We have built several fine ships under it but not enough of them; and, so far as the mail contracts are concerned, the system is discriminatory against those lines not on mail routes. The President recommends abolishing subterfuges and setting up a new and correctly labeled subsidizing program. He would provide Government aid in ship building to an extent that would offset the differential between the costs of building ships in this country and abroad, and further aid to take care of the higher cost of operating American ships.

A difficult situation promises thus to become clarified. There is much merit in the President's remarks, but when analyzing them, basis for doubt is found. It would indeed be a splendid thing to throw off the disguise and proceed to build a finer Merchant Marine with direct Government aid. All thinking people believe we need more ships for reasons widely known and often discussed in these pages. But to build them with Government cash, whether by one scheme or another, is not the same simple thing as rehabilitating a park with PWA money. We have had shipbuilding scandals before; unlawful practices, abuses, and favoritism have reared their ugly heads. They can easily show up under a direct subsidy plan and it is to be feared that they will unless Congress, while striving to solve this problem, first thoroughly canvasses every avenue of approach to the question and effectually blocks off those where chicanery and corruption might later enter. Then and only then may we expect improvement in our merchant fleet.

Pot and Kettle

IN 1925, when America was in the throes of the famous Tennessee "monkey trial," British journals and commentators missed few opportunities to point out America's backwardness. They, of course, were quite right: we were backward. (Tennessee was a part of the American nation.) It came down to this: some Americans—state legislators—were trying to settle a question which a more advanced community would regard as the prerogative of scientists. The Scopes anti-evolution law remains on the statute books of Tennessee today, and it is still illegal, therefore, to teach, in any tax-supported school or university in Tennessee "any theory that denies the story of the divine creation of man as taught in the Bible and to teach, instead, that man descended from a lower order of animals."

It is frequently asserted that this law is only a gesture to appease the people of the community. But if it did not represent the majority opinion of the community to which it applies, the recent attempt to repeal it doubtless would have succeeded. Therefore it unquestionably does represent the majority opinion, and the intelligentsia of Tennessee can no more disown it than the intelligentsia of America can disown Tennessee; all concerned are Americans.

And now Britain has unexpectedly discovered right on her own doorstep an awkward scientific "scandal" of her own, deposited there, too, by one of her own scientific men. Sir Ambrose Fleming, the great electrician whose "Fleming valve" has had so much to do with radio, in his presidential address to the noted Victoria Institute, states his belief that "this sedulously propagated hypothesis of man's age-long evolution . . . is the product rather of the imagination than based on indisputable evidence," and that Adam was created in the year 5411 B.C.

Does Sir Ambrose Fleming stand alone in Britain in these assertions? No, for friends—all Britons—gather round him. G. K. Chesterton, famous English journalist and author, rejoices, in *The Illustrated London News*; a staff writer in *The Sphere* is glad, he says, that Sir Ambrose has thrown a brick at evolution.

It becomes evident that opinion in Britain is not so solidly behind science as British critics of backward America have declared, and that British commentators will now be less inclined to point a finger at the monkey business in Tennessee than they were before the occurrence of this latest monkey business in London. Otherwise the pot would be calling the kettle black.

Identification

NOT to be outdone by New York City, other communities are at the moment intensifying the years-long drive for fingerprinting civilians. While some agitation to compel fingerprinting of every individual is still in evidence, the present activity is voluntary on the part of police departments and of individuals. Police bureaus offer to take the prints of any who wish such service, the records to be classified and filed apart from criminal prints.

Despite reassurance from many authorities and the example set by numbers of public men, people generally still seem to believe there is some criminal stigma attached to the simple fact of placing one's fingerprints on record. This, regardless of the fact that about four million of our soldiers were fingerprinted in 1917 and 1918, and without demur. Nowadays, as criminals widen their kidnap activities, possible victims among those whose wealth is tempting to crooks are frequenting fingerprint bureaus in increasing numbers. Their records may later prove valuable as positive indentification not only of themselves but perhaps, as has once already happened, of the hideouts where they were imprisoned. Amnesia victims and economic casualties, of whom there has been a higher percentage than usual under the strain of recent years, would be quickly identified were their prints on file. The identity of victims of disasters, on sea or land, and unconscious or deceased victims of city street accidents, often unidentifiable by ordinary means, would quickly be learned so that relatives might be notified. Fingerprints also serve as irrefutable signatures on documents or checks.

As publishers of a standard work on fingerprints and of a magazine long concerned with the problem of combating crime, we commend those police departments which now are offering the services of their fingerprint bureaus to the furtherance of this scheme. Particularly do we wish to thank the police of New York City for starting the current drive and helping promote public acceptance of the idea.

Back to Prosperity

Housing Program Offers Tremendous and Varied Market to Construction Industry, Durable Goods Producers, All Labor, and Business Generally

By JAMES A. MOFFETT
Federal Housing Administrator

(In Two Parts. Part I)

OUR Better Housing Program is America's way back to prosperity: and America is on the way. The National Housing Act, under which that program has been developed, was inspired and approved by President Roosevelt as a sure-fire means of restoring prosperity to this country. It would, he foresaw, create new business for the construction industry; this would inevitably result in big demands upon the durable goods industries; and that, in turn, would mean stimulation of all business.

What the President anticipated when he signed the Act, June 27 last, is now taking place. Railroad car loadings are steadily increasing. The business of certain corporations manufacturing housing materials is 400, 500, even 600 percent greater than it was one year ago. At the call of the builders, sleeping capital is waking up and employing more workers and creating new wealth.

NEVER before, by legislation or otherwise, in this country or any other, has so rich an opportunity been made for business as is created by the National Housing Act.

Never before has so tremendous and varied a market been offered to the construction industry, durable goods producers, skilled and unskilled labor, and to business generally. Never before, incidentally, has there been such challenge or such inspiration to the inventor, to the fabricator, buyer, and seller of new devices for household convenience, of industrial machinery, and of transportation equipment.

It is the Federal Housing Administration's duty to sell the American people the idea that now is the best time for them to modernize and repair their homes and industrial plants and to build the new residences which are so badly needed. That idea is fast taking hold of the popular mind. Already in more than 2600 cities and towns it is striking down through the whole community structure to the point where each home owner finds a canvasser on his doorstep waiting to tell him why he should modernize and where he can, if necessary, borrow the required money on easy, convenient terms. In over 3000 other communities, Better Housing Committees are perfecting organizations for house-to-house canvasses to promote the idea.

Two photographs that tell a vivid story of the rebuilding of an old eyesore into a comfortable and attractive modern home

We figure by a very careful and conservative estimate that the Better Housing Program thus far has generated over 400,000,000 dollars' worth of modernization work.

As this is written (in March), I have on my desk pledges from some of the country's greatest industrial corporations to undertake without delay modernization of plants and equipment that will cost more than three quarters of a billion dollars.

And all this has come from seven months' actual organization work and before the building season has opened up in the greater part of the United States. In other words, so much has been accomplished in modernization and repair in the autumn and winter months that the big industrial corporations — the durable goods industries—have felt the reviving touch of it and have joined that army of modernization and construction whose marching feet are already on the road back to prosperity.

Consider, now, two things: First, why modernization, repair, and new building are vitally necessary to the welfare of America; and second, how our Better Housing Program makes it profitable and more convenient than ever before for the nation to do those jobs.

LAST August, when the Housing Administration's field work really got under way, there were in the United States at least 13,500,000 homes in need of repair. How many of the 29,000,000 buildings of all sorts in the land needed some degree of modernization, it is impossible to say; but we may safely assume that the majority of them needed it, since modernization means bringing a home or industrial structure up to date in condition and equipment.

Neglected during five years of depression, the homes of America were, in many millions of instances, far from up to date, in both exterior and interior conditions. They needed, the experts told us, 3,000,000 new roofs, 6,000,000,000 feet of lumber for repairs, and more

With Housing

We have been fortunate, indeed, in obtaining Mr. Moffett's illuminating interpretation of the aims of the National Housing Act and of the reasons for believing that a properly developed housing program will bring prosperity. His arguments are sound—in this and the second part of his article which follows next month.

In public apathy, however, (or caution), there is a stumbling block which so far has retarded expansion of this program. Thinking people know full well that the housing program is feasible and that the accruing benefits to everyone are great; so it is up to them—to all of us—to bend every effort toward its rapid fulfillment.—*The Editor*

than 1,000,000,000 dollars' worth of paint and varnish.

If the salesmen of all the industries and businesses concerned could sell the goods to every real "prospect" for home modernization alone, the experts said, they would do six billion dollars' worth of business.

Does that sound excessive? There are in our homes, according to the surveyors of the situation, 10,000,000 kitchen ranges that are obsolete; *and* 500,000 electric refrigerators; *and* 800,000 electric washing machines. When we move over to the field of industrial plants and transportation facilities, the modernization needs run into figures equally impressive, that show what must be done.

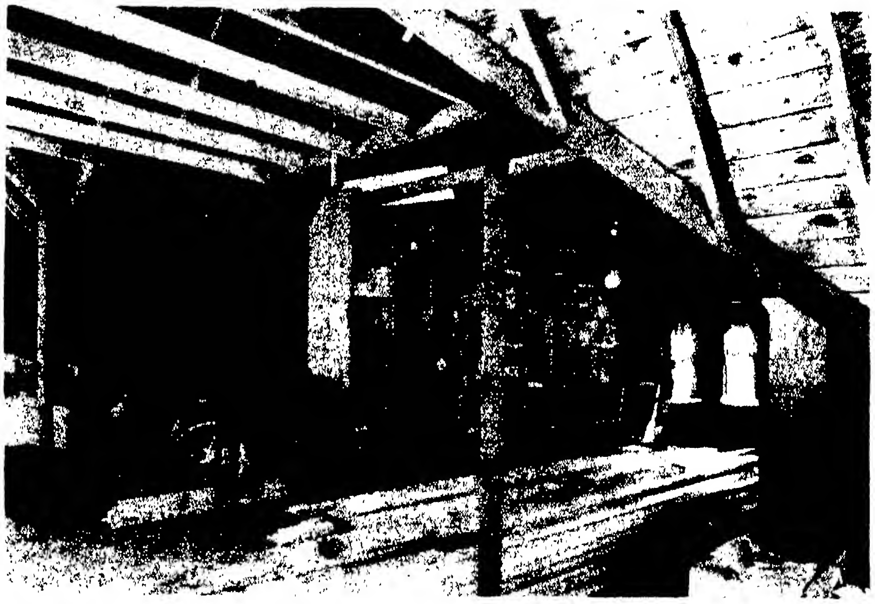
In our eastern states, we are informed, it would cost well over a billion dollars to get rid of the 26,000 grade crossings where motorists are endangered. The railroads need 240,000,000 dollars' worth of new locomotives; and of their 23,000 passenger day-coaches, 4400 are built of wood and 2400 part wood.

Any industrial machinery that is ten years old, the experts claim, can be classed as obsolete, and more than half of the machinery in our factories has been there over ten years. Estimates are given us that America's industrial plants can spend 7,000,000,000 dollars in new machinery and 2,500,000,000 dollars in electrical equipment before they can say they are up to the minute.

But opportunity, rich and varied, inviting both the manufacturing concern and the individual inventor, points to still other fields, some of them practically brand new.

There is, for example, air conditioning, which some of the students say should yield 200,000,000 dollars a year, while others put its annual possible receipts as high as 1,000,000,000 dollars; new materials in farm equipment; and stupendous expenditures by municipalities

These things I have mentioned are the high-lights of the nation's needs in modernization and repair. There is not space here even to list the countless smaller items which nevertheless total hundreds of millions of dollars—articles ranging from sash-cords to sewing machines.



Rebuilding an attic provides an extra room in the home and at the same time creates work and profits—essentials to the return of more prosperous times

Nor may I linger on the details of our need of new homes. Some of the estimates are that we must have 5,000,000 or more new residences before we can say all our people are decently housed. But for purposes of illustration, suppose we assume that we need only 2,000,000: We see that there is a total of about 3,000,000,000 dollars' worth of new homes to be erected as soon as possible—conservatively figured at a low average of 1500 dollars per residence.

Markets for the builders, contractors, building supplies dealers, and so on, running not only into the hundreds of millions, but into the billions! Not at some time in a far, vague future, but now—TODAY!

Mr. Moffett's illuminating discussion of housing facts will be concluded next month.—The Editor.

SAFETY IN THE AIR

More Improved Weather Service Needed . . . New Radio Aids Important . . . Weeding Out of Incompetent Pilots Held to be a Prime Necessity

By REGINALD M. CLEVELAND

THE airlines of the United States again set an enviable record for safe flying during 1934 with 4,878,655 miles per fatal accident.* But accidents happened which should not have happened and there is still room for improvement in providing for the safety of air travelers.

It is perhaps unnecessary to recall that the year 1934 was a particularly trying one for air transport. Hard upon the heels of the cancellation of airmail contracts, still unjustified by any prosecutions for alleged "fraud and collusion," temporary airmail legislation was set up under which contractors, new and old, secured routes at rates which were frankly sacrificial. Under these rates they have been going rapidly into the red, month by month. Even those with the deepest financial reserves cannot continue very much longer on such a basis. The aggregate losses for the last seven months of the year were about three million dollars net. Individual losses ranged from 10 percent of total capitalization to 100 percent.

Under these circumstances, it was perhaps not reasonable to expect that very much should be done toward improving service and safety in the air. It may truly be said, however, that the lines met their very real and very pressing troubles in an admirably courageous spirit and did provide astonishingly fine service with faster and more frequent schedules and improved correlation of services.

IT was noticeable during the year, however, that, with improvement in aids to bad weather flying, more bad weather flying was attempted than had hitherto been the case, and in view of certain of the transport accidents it is difficult not to feel that the eagerness to maintain schedule was not manifested at some cost to safe procedure.

No one close to the subject of the progress being made in the instrumentation of planes and in the radio aids to flight, doubts that scheduled blind flying and actual blind landings will soon become a commonplace. The danger lies in anticipating this condition before it has fully arrived. Pilots have by no means had sufficient experience with the new aids and instruments at their command to make it safe and proper procedure to place full reliance upon them when flying passenger loads.

To pass an examination in blind flying under a hooded cockpit and to do sufficiently good instrument flying under these conditions, with a check pilot who is not hooded aboard, to meet the Department of Commerce requirements, is one thing. Most airline pilots with a transport rating have been able to do this successfully. To get into actual bad weather, with zero-visibility conditions, and keep on course or reach destination after a protracted period of such flying, is altogether another thing. There are veteran transport pilots who can do this and have proved it, but this type of flying cannot be regarded as safe until the run-of-the-mine pilots and co-pilots on a given airline can do it, too.

Despite the great improvement which has been made in a year in weather forecasting, and the still greater improvements which appear to be around the corner through the further development of the air mass analysis method, old man weather is still unfortunately erratic, and planes still get into spots in which are made the utmost demands for skill and real blind flying and navigation.

THE safety record of the year would certainly not have been even as good as it is had not the improvement in weather information already noted come about. There was a period in the early part of last year when even the Federal broadcasts of airway weather in widely scattered sections of the country passed through a highly dangerous period of over-optimism.

The writer will not soon forget 40 minutes spent with seven fellow passengers in the vicinity of New Orleans in a big transport plane which was caught in a torrential thunderstorm with a ceiling ranging from zero to about 200 feet over the tree-studded bayous, while over the radio from an airport in the same area came the repeated broadcasts: "1800 feet, light rains." It was only the exceptional skill of the veteran transport pilot at the controls and the fortuitous circumstance that it was just at dusk and the lights of a Federal emergency air-

*Another statistical tabulation presents the figures in a different manner; 10,727,026 passenger miles were flown per passenger fatality during the year 1934.

The Sperry gyropilot takes hold, permitting the pilot and co-pilot to turn their attention to navigation and weather problems which otherwise would necessarily be more or less slighted

port flashed on when about 20 minutes of gas remained in the tanks which led to a happy landing instead of what might have been a messy crack-up.

Similar experiences reported from a number of sectors at about that period led to marked improvement in the accuracy of current weather broadcasts, followed by increasing accuracy of forecasting through the balance of the year. This did not prevent a number of passenger planes, however, from coming to grief in bad weather, some with serious casualties and others, smiled on by the gods of luck, unharmed.

It is widely felt that too much reliance has been placed on the radio-beam system and that more exhaustive training in enabling pilots to fly compass courses blind is strongly indicated. Not that the directional beams are not useful. They are, of course, vastly so, and cover the country with a protective network of signals without which the present regularity and safety of air transport would hardly be possible. But, conditions of polarization at certain times of day, such as dusk and night, sometimes limit the range of the beam from its normal 100 miles or so, to about 30 miles. Moreover, its path is relatively narrow and consequently difficult to follow.

Structural strength of transport planes plays an important part in air safety. In this crash, the entire passenger cabin remained intact; only the pilot and co-pilot were slightly injured

IF, under certain conditions, a pilot gets into sudden thick weather, he may easily lose the radio beam through drift. There have been several cases of this kind where the beam has not been picked up again until its source had been passed and the pilot finally discovered that he was flying away from his destination instead of towards it. As one cure for this evil, it has been suggested that sharper differentiation in intensity of the beam signal be required, so that the flier may more readily know when he is approaching or receding from the beam station.

The Bureau of Air Commerce is, of course, sincerely interested in promoting flight safety. It has recently tested and recommended for adoption the Army system of blind landing. This system is to be tried out on a large scale over the lines of TWA—not, however, it should be emphatically pointed out, with passengers—until a complete and satisfactory series of thorough-going tests has been flown.

The system is very adaptable and elastic and appears to be quite suitable for military cross-country flying, where portability of equipment and similar factors are of prime importance. It consists in placing two radio transmitters—which may be portable—at specified distances from the boundary of an airport, and using them to determine the distance of the plane from the airport.

Receiving the signals of the nearest of these stations to the boundary by means of the Kruesi radio compass, which has proved so satisfactory as a homing device,* the pilot passes over this station and then tunes for the one further from the boundary. Immediately after passing over the second transmitter—a fact which he knows by the character of signal received, or by sudden complete absence of signal—he makes a 180 degree turn, again picks up the outer transmitter, flies over it and picks up the inner transmitter, maintaining a predetermined altitude by means of a sensitive altimeter. As he crosses the inner transmitter, this time of course approaching the field, he puts his plane into a fixed glide which will bring him down to a landing in the field.

This method, developed by Captain Albert F. Hegenberger, the noted blind flying pilot of the Air Corps, has been successfully applied by him and by many other pilots in military ships. It is certainly worth investigating for commercial use. Most airline operators, however, are still inclined to the belief that the more positive method of blind landing provided by the bent radio beam system will prove a surer solution of the problem. Early difficulties with this method included costly installation, a flight approach limited to a single direction, and a landing beam too fixed in character to suit the characteristics of varying aircraft. The method has now been greatly improved and simplified, however, through the work of Harry Diamond and other engineers of the Bureau of Standards so that these objections have been swept away.

The transmitter required for the bent beam can now be located in a pit in mid-field, giving a 360° path of approach and has been so simplified as to be greatly reduced in cost. Furthermore, the angle of the beam itself can be varied to suit aircraft characteristics, and is said to be accurate to such an extent that a pilot entirely befogged can be sure of his position laterally within 50 feet and vertically within 5 feet, a margin amply sufficient to assure safe blind landings. Apparatus to provide this system has just been installed at Tempelhof, Berlin.

*See page 240

Distinct gains in safety, as well as in passenger comfort, have been made by wider application of the automatic gyropilot to transport planes. TWA's whole fleet of speedy Douglases are now thus equipped with Sperry pilots and the human pilots of the line enthusiastically testify to their great help in easing the strain of flying, keeping the plane on fixed course and giving them time and opportunity to attend more completely to navigation and weather problems.

Until the day dawns of the aircraft completely radio-controlled from the ground, however, the human equation cannot be cancelled out from the matter of flight safety. Training, yet more training, and culling are still the prerequisites.

FEDERAL authorities and airline operators would be glad to weed out the pilots whom they both know are not capable of complete blind navigation and not fully able to meet that thousandth chance when mechanical and electrical aids prove inadequate. The top pilots of the country's air systems would also like to see such a condition. As an obstacle in its path, however, stands the pressure of the less competent pilot who might be one of the tares in the wheat field. He finds it all too easy to get the backing of the National Labor Board. The drive for safety cannot come in full measure to the airlines until they, and the Bureau of Air Commerce, find it less difficult to weed out the unfit and the incompetent for cause.

Double Stars

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

There are at least four prerequisites for a successful program of astronomical observation: a good telescope, a good climate, a good eye, and good judgment.

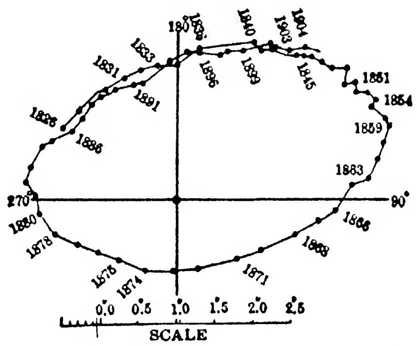
At this point many a reader will stop and in spirit will inquire, "But why a good eye? Are not almost all observations made nowadays by photography?"

In many fields of work this is entirely true. The whole study of spectra is made on photographs; so are the greater part, though not all, of accurate measures of the positions of the stars. Measures of the heat of stars and planets, and the most precise determinations of their light, are made with thermo-electric or photo-electric devices of one sort or another. But there are certain important lines of astronomical work in which direct visual observation reigns supreme.

One of the most fruitful of these is the study of double stars. For a century and a half subsequent to the invention of the telescope, astronomers had known that a good many stars were double, but no one seems to have taken the trouble to measure the distance and direction of one of the pair from the other till Herschel tried it in 1780. A few years' observation showed him that, while most pairs remained substantially fixed in relative position, a few exhibited a regular and progressive motion obviously of an orbital nature. Then, in his own words, he felt "like Saul, who went out to seek his father's asses and found a kingdom." The realm of gravitation extended to the stars as well as the solar system.

It was half a century later, however, that Wilhelm Struve began the first systematic search, recording and measuring all pairs which were separable with his nine-inch telescope—more than 3000 in number. Later campaigns with larger telescopes have added to the list, though only Aitken, at the Lick Observatory, has discovered as many pairs as Struve. His recent General Catalog, summarizing the work of the past century, contains more than 17,000 double stars. The southern heavens, south of declination −31°, are not included in this. When the surveys which are still in progress are completed, about 5000 additional pairs should be added to the total, bringing the grand total to 23,000.

Practically all these discoveries have been made by looking at the stars directly through telescopes. The primary reasons are that the vast majority of double stars have a very small apparent separation. Great numbers of pairs, including many of the most interesting, are so close that they can be resolved only with large telescopes. Even with ideal optical conditions the waves of light coming through the circular aperture of a telescope can be concentrated, not into a mathematical point, but into a small "diffraction disk." The size of the disk varies inversely as the diameter of the clear aperture of the telescope, according to the formula $d = \frac{4''.5}{A}$, when d is the diameter in seconds of arc and A the aperture in inches.



Illustrations from Russell, Dugan and Stewart's Astronomy, courtesy Ginn and Co.

Orbit of a binary or double star, Xi Ursa Majoris, having a period of 59.8 years. This is the apparent, not the true, orbit, the orbit being seen from our vantage point more or less obliquely and distorted by foreshortening. The little wiggles in the curve merely show the kind of slight differences in observation which cannot be eliminated entirely and, at worst, represent inaccuracies of about one tenth of a second of arc. After smoothing off these irregularities, the curve is an ellipse

With Struve's nine-inch telescope all stars therefore appeared as disks 0″.5 in diameter (which is more than 10 times as large as the real angular diameter even of Betelguese). A pair separated by 0″.5 would appear to be in contact, however wide the real interval in miles between them. With a separation of 0″.4, there would be a single elongated image. Pairs much closer could hardly even be detected. The 36-inch Lick refractor gives a "spurious disk" of only 0″.12, and reveals thousands of systems which are utterly beyond the power of the smaller instrument.

With a suitable eyepiece of high power the skilled visual observer can detect and measure equal pairs right up to this theoretical limit. Unsteadiness of the air, of course, may smear out the images, so that he can do nothing. The photographic plate is at a hopeless disadvantage. Star images on the negative at best are little round bundles of black silver grains, many times larger than the tiny optical images of the stars themselves. There are several reasons: the light spreads out on the plate, so that the images of bright stars are bigger than those of faint ones and, during the minutes of exposure, when the air is as steady as can be hoped for, the star seems to dance about—not much, but enough to blur its image. Even on the best plates taken with great telescopes it is rare to have star images less than 1″ in diameter, some eight times as big as the optical image itself. Moreover, when the seeing is a little unsteady, the visual observer can take advantage of a favorable moment to make his setting, while the plate records only an indiscriminate average of good and bad—which for the present purpose is much like a mixture of good and bad eggs.

For pairs of unequal brightness photographs are at a still greater disadvantage. The fainter star may be utterly drowned in the expanded image of the brighter and, even if they are widely separated, the image will be over-exposed or else the other under-exposed, and no accurate measures can be made.

There is, therefore, not the slightest hope—or fear, according to which standpoint we adopt—that other means of measuring double stars will put the visual observer out of business. He appears to be in no danger of technological unemployment.

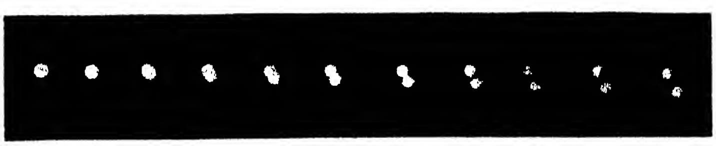
Double star observation has been, all through the past century, one of the most altruistic of occupations. One in two or

The Realm Where the Visual Observer Still Reigns Supreme . . . and Will not be Dethroned

three hundred of the pairs a man discovers may turn out to be a rapid binary, completing a revolution in 20 or 30 years, so that he may live to follow it all the way around and compute its orbit. But the overwhelming majority move so slowly that 50 or 100 years are required to show that they are actually changing their relative position. The discoverer's satisfaction here must be that someone a century or two after his death may say, "Thank goodness that faithful old fellow made such reliable measures."

Just because past observers have been faithful and enthusiastic, astronomers of the present suffer from an embarrassment of riches. Like Mother Goose's old woman, they have so many children that they don't know what to do. In principle, every double star should be accurately measured at least twice at an interval of 20 years or more, to pick out the rapidly moving pairs, which should be observed regularly, from the great mass which change so slowly that it is quite sufficient to keep tab on them three or four times a century (provided the observations are accurate). In practice, an observer usually goes over his list at a shorter interval, but he finds that the most interesting objects of all have been neglected.

FOR wide pairs (more than three or four seconds of arc) fairly comparable in brightness, photographic observation is easily possible and more accurate than direct visual measures. But, even so, there is a staggering amount of labor left for the visual observers.



A photograph by J. A. Anderson, showing the diffraction image of an artificial double star observed through a telescope. The first one shows the image of a single star, but the remainder show the gradual separation of the images of the components of the double, as the aperture of the telescope is step by step opened up. First we see the image slightly oblong, then elongated, and presently it breaks, like an amoeba dividing, and finally the aperture is wide enough to separate the components quite sharply. The larger the aperture of the telescope the closer the doubles it can separate

At this point the function of good judgment enters. Why do we observe double stars, anyway—is it more than a harmless hobby? To obtain knowledge, of course; but the mere knowledge that a star is double is of little profit. In the first place it is from double stars, and from them alone, that we can get direct information about stellar masses. Without this we could not even make a start at a physical interpretation of their internal constitution or their nature. To get the mass we must know the star's distance—given by its parallax—and its orbit. Thousands of good measures of parallax have been made in the last 30 years, but there are only 100 pairs or so for which we have even tolerable orbits. This happens because one cannot calculate the orbit of a double star reliably until it has been obscured over the greater part of a revolution. With a century of observation available for the easier pairs, and less than half as much for the more difficult objects, only pairs with periods less than about 200 years in the first case, and 80 or 100 in the second, are yet available.

Now the stars are much more alike in mass than in anything else which means that a period of 80 or 100 years corresponds to a distance comparable with that of Neptune from the sun. To be resolved telescopically such a pair must be within three or four hundred light years—which is much nearer than the majority of the stars of the eighth and ninth magnitudes. Our list of orbits is therefore a selected list of stars nearer than the average. The few systems with large apparent orbits and easily observable with small telescopes have, without exception, large parallaxes and are among the nearest stars. Suppose, then, that a modern observer starts out to hunt for double stars which are likely to be in rapid motion, and add to our lists of reliable orbits and well determined masses, during the lifetime of the younger at least of present-day workers. What should he do? The obvious answer is to observe the *nearer* stars. Among these he can detect pairs of small real separation and of correspondingly short period.

Long lists of measured parallaxes, containing dozens of nearby stars, have been available for a decade or more. But no one seems to have put this simple suggestion into practice until a young Dutch astronomer, Gerrit Kuiper by name, came to work at the Lick Observatory. In the course of a carefully planned campaign of double star observation he set out to examine all stars known to be within 80 light-years from the sun, with the 36-inch telescope on good nights. The results have been amazing. More than 100 new double stars have been found, and a dozen or more are very close. Half of these are faint red dwarf stars with large parallaxes, whose companions appear so close that their real distances probably average less than that of Saturn from the sun. These faint stars are doubtless less massive than the sun. One third the sun's mass for each star of the pair would be a reasonable estimate. On this basis Kepler's law indicates that the periods should be from 30 to 50 years. A few decades of observation should give good orbits, and more than double our knowledge of the masses of these faint red stars.

One of the dozen is much more remarkable—the ninth magnitude star B. D.-8°4352 (that is, star Number 4352, in the zone 8 degrees south, in the Bonn Durchmusterung Catalog). This has the unusually large parallax of 0".15, making its distance only 22 light-years. Last July it was seen to be double, with a separation of 0".20, which (apart from the effects of foreshortening) corresponds to a distance less than that of Mars from the sun. Later observations showed a motion in angle of nearly 90 degrees in four months! At this point the star was lost in the evening twilight, and further observations could not be made till February. If it keeps up its rate of motion it will complete a whole revolution by the end of this year—indeed, the stars were drawing closer together and moving faster when last observed, so that the period may be even less than a year.

THIS brilliant discovery is only an incident in Dr. Kuiper's carefully designed program. It has led to other important results. A spectroscopic study of these nearby stars has found two new white dwarfs, one about one hundredth as bright as the sun, and the other only one six-hundredth. Both have well-measured parallaxes, so that there can be no doubt of this conclusion. The spectra have been observed at Lick and Mount Wilson. Adams and Humason at the latter observatory report them similar to that of the Companion of Sirius. Kuiper considers that this indicates a still higher temperature. In actual diameter these stars can hardly be bigger than Uranus or Neptune, and may be as small as the earth.

These results from a single year's work show that there are still as good fish in the sea as ever were caught—indeed better. The main thing is to know where and how to catch them!—*Princeton University Observatory, March 7.*

SCIENTIFIC AMERICAN'S Monthly

DIGEST OF AVIATION

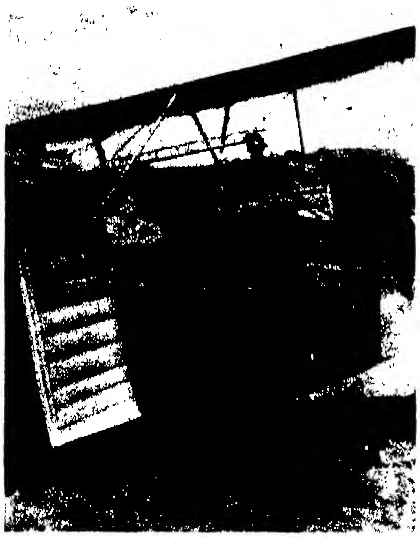
By PROF. ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University

THE CONDOR CARGO CARRIER

UNDER Army Air Corps influence, airplane cargo carriers are receiving a decided stimulus. The Curtiss Condor cargo plane is an excellent and rugged transport of biplane construction, which is nowadays somewhat of a distinction. It is the splendid arrangement inside the fuselage which is of the greatest interest.

The interior dimensions of the fuselage available for cargo space are relatively immense. The length is 22 feet; height 6 feet 6 inches; width 6 feet 3 inches. These would have been unbelievable figures four or five



Monorail hoist with which large cases can be loaded into the Condor

years ago. The main cabin door, constructed of aluminum alloy sheet, and with a similarly constructed hatch, makes available a clear opening of 6 feet 6 inches in height and 6 feet in width. No wonder that it is possible to put a complete automobile into the cargo space.

The standard cabin furnishings include 10 pyralin windows each $12\frac{1}{2}$ inches in diameter; a main entrance door; two emergency exit doors, one on either side of the cabin; a hatch in the pilots' compartment for fueling and servicing; a hatch just aft of the cabin in the floor for parachute exit and the dropping of food and other items in containers by parachutes; a first aid kit; a lavatory; a complete cabin heating installation with 12 individually controlled outlets; and two cabin dome lights which

The cargo space inside the Condor easily accommodates an automobile

also include air exhaust ventilating units.

As a troop transport, four folding benches are carried, which will seat 16 soldiers with ample space remaining for packs, rifles, and so on. As an ambulance ship, six welded steel litters are provided. These are supported in the front of the cabin, three on each side, leaving the remainder of the cabin clear for other personnel or equipment.

As a freight carrier, a monorail hoist, loading ramp, block and tackle, and hold-down eyes are provided. The monorail hoist consists of a rope-driven screw hoist and trolley which runs on an aluminum alloy I-beam supported over the door by two diagonal steel tubes with welded fittings. Attachment is made at the ridge pole on the center line of the door by a screw fitting. The track can be disassembled merely by unscrewing this fitting. A removable section of flooring brings the door sill level when the tail of the ship is on the ground. Two channel sections provide a ramp on which standard engine dollies can be rolled on board the ship. For moving freight, engines, and so on, forward in the ship with the tail down, a block and tackle is provided.

We attach particular importance to these developments which represent the highest type of practical engineering. There is no doubt that from Army use, cargo planes of this type will pass into employment on our airlines.

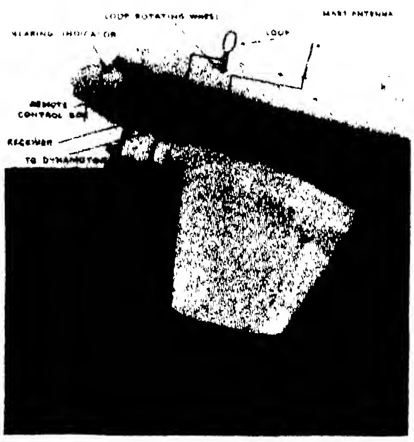
THE KRUESI RADIO COMPASS

WE are indebted to Frederick A. Lutz of the Fairchild Aerial Camera Corporation for a description of the Kruesi radio compass, originally developed by Geoffrey Kruesi at the instrument section of the Army Air Corps Experimental Station, Wright Field, Dayton, Ohio. The Kruesi compass is the key unit in the blind landing system adopted by the Army and has been favorably passed on by the Bureau of Standards and recommended for use on airlines. It can be used in connection with any broadcasting station and, as compared with the radio beacon, it has the great advantage of freeing the pilot from following a definite

The cargo biplane, described above, in flight

airway, and is therefore particularly well adapted for non-scheduled flying. Moreover it is extremely simple in use, and requires very little training for its operation. It has a longer range than the radio beacon.

The Kruesi compass consists of a single compass-receiver unit, mounted in an out-of-the-way place on the ship; a remote-control box mounted conveniently to the pilot; a bearing indicator mounted on the instrument board; a fixed loop for homing purposes (which may also be rotatable so as to serve both for homing and for direction finding); a mast antenna; and a dynamotor and the airplane storage battery to supply the necessary current.



How the various parts of the Kruesi radio compass are disposed within the fuselage of a plane. See text

The compass receiver has a broad frequency range, and embodies a superheterodyne receiver with five tubes. The remote-control box includes a tuning dial, a convenient handle for turning the tuning dial, a pair of switches, and a jack for the headphone piece. The bearing indicator has a black face with pointer and scale coated with luminous paint. This indicator is very sensitive and is immune to movements of the airplane; static has apparently little effect upon it.

The streamlined demountable loop, 21 inches in diameter, is rotatable through 360 degrees. A standard mast antenna projecting six to eight feet from the fuselage is used in conjunction with the loop. The receiver unit, bearing indicator, loop, and rotating mechanism weigh approximately 45 pounds.

When using the compass, the pilot selects the station to which he wishes to fly, switches on his headphones and sets the tuning dial. Then he switches to the bearing indicator. If the loop is along the right line of travel, and the pointer is at zero, the airplane is heading towards the broadcast station; if the indicator is to the right of zero, the airplane is heading to the right or vice-versa. This is all there is to "homing" or keeping on a course.

But the pilot can also use the instrument as a position finder. He or his co-pilot tunes on any two stations in succession, and by suitably rotating the loop gets the bearing on both stations by use of the indicator. If the two bearings and the stations are marked on the map by straight lines, the intersection of the two lines gives the position.

Professor Klemin's Notes and Comments on All Phases of the Field of Aviation are a Regular Feature of The Scientific American Digest

Twin Engines for the Private Owner

IN England, twin-engined airplanes for the private owner are popular and deservedly so. If twin-engined ships are safer for airline work, and therefore more desirable than single-engined types, why should they not be employed in private flying?

The Crusader, designed and built by Thomas M. Shelton of the American Gyro Company, now constitutes an excellent American example of this classification and is being test flown with success. It should also be useful as a feeder to the main airlines.

The Crusader can be used either as a four or as a six seater. It is powered with two 125 horsepower Menasco, four-cylinder, inverted air-cooled engines, supercharged to develop 156 rated horsepower at sea level. Wind tunnel tests conducted at New York University gave evidence of excellent aerodynamic qualities.

Preliminary flight tests at Denver showed a landing speed of 60 miles per hour at an altitude 5000 feet, and high speed, steady flight with only one engine running.

As our photographs show, crew and passengers are housed in a short, well streamlined nacelle, with tail wheel at its rear end, while the tail surfaces are carried on booms extending from the wings in the rear of the engines. Thus the rudder is directly in the slipstream of the propeller, a valuable feature in securing control with one engine not firing. Many engineers are also of the opinion that this type of construction is somewhat lighter than the conventional fuselage type, and that it is quite as efficient aerodynamically. The plane is in general a fine example of modern design, both aerodynamic and structural. Landing gear is retractable. Construction is all metal.

Certain points in the cabin accommodation are worthy of note. The cabin, which is quite roomy, seats four passengers and has an average width of four feet. Entrance is by a door on the right hand side of the machine, the opening of which extends partly around the top. This eliminates an opening in the top surface of the low wing, which is undesirable from a structural point of view yet frequently employed in small, low-wing machines.

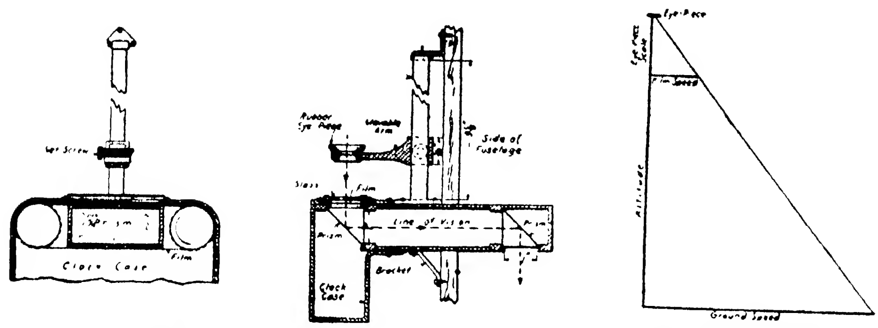
A new material, Plastocele, is used for the windows, which provide splendid vision. Plastocele is used because of its low weight and replacement cost as compared with glass and because it can be so readily molded into the streamline body.

Two Million Dollars an Hour

THE severest test to which an airplane can be submitted involves the following maneuver: The machine is put into a vertical dive, from a great height, with power full on. When the greatest possible speed—the terminal speed—has been attained, the

Below: The mounting of one of the inverted air-cooled motors in the twin-engined plane for use by private flyers

The twin-engined plane for private owners, in flight. Note the well-designed out-riggers supporting the tail surfaces



Two drawings of the principal parts of the Gatty ground speed meter, and, at right, triangle indicating how the ground speed is shown by the instrument

pilot pulls his stick rapidly back, bringing the airplane into level flight. The machine during this period describes a tight curve, and a tight curve at tremendous speed means a very high centrifugal force which is balanced by an equally high lifting load on the wings. Measurements of the centrifugal force show that the acceleration may be as high as 8 g, or eight times the force of gravity. Thus a pilot weighing 150 pounds is pressed down on his seat with a force of 1200 pounds, the blood may partially leave his brain, he may be temporarily blinded and even lose consciousness. An additional hazard lies in the fact that the wings may come off due to the high centrifugal load at the very instant when the pilot is physically incapable of using his parachute.

Naturally, the test pilot who puts a new airplane through a power dive and subsequent flattening out, is well paid. *U. S. Air Services* reports that Vance Breese, veteran barnstormer and experienced test-pilot, was recently employed by the Northrop Company to put a Northrop Delta through such a maneuver. The Delta is powered with a double-row Pratt & Whitney Wasp of 750 horsepower and is reported to have a top speed of 280 miles an hour. Knowing the dangers involved, Vance taped himself from head to foot to help him withstand the terrific strains. He took the plane up to 20,000 feet and dived through 16,000 feet to within 4000 feet of the earth before pulling out. The speed indicator passed through 200, 300, and 400 miles an hour, finally reaching 425 miles an hour when the instrument broke. But the test was entirely successful.

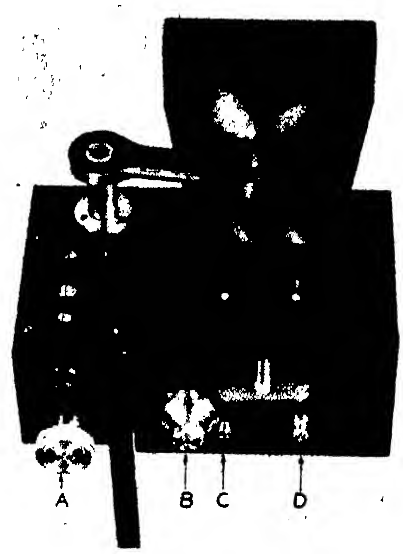
Vance Breese received 8000 dollars for his effort. The dive occupied 15 seconds, so that the rate of remuneration was 32,000 dollars a minute or nearly two million dollars an hour.

Yet we cannot say that the pay was too high!

Gatty's Ground Speed Meter

HAROLD GATTY and his partner, Wiley Post, will long be remembered for their famous "round the world" flight in 1931. On this trip, it will be remembered, Gatty was the navigator, while Post was the pilot. In preparation for this flight, Gatty prepared and used successfully a ground speed meter which since, in refined form, is being largely employed by the Army Air Corps and Navy Bureau of Aeronautics. Writing in *Aero Digest* Lieutenant Commander Weems, himself an authority on navigation, describes this instrument.

In the Gatty ground-speed meter there is, projecting beyond the side of the fuselage, a periscope case with a right triangle prism at its end, one side of which is horizontal. The line of the observer's vision is through the rubber eye-piece mounted on a movable arm; through a constant speed transparent film; then a prism; next, a horizontal tube; and then through the second prism directly



The ground speed meter. A, eye-piece adjustment. B, drift measurement adjustment. C, speed control. D, start and stop button for clock

to the ground. The film is carried at a constant speed over the first prism by a clockwork mechanism and is marked with parallel lines at right angles to its motion. This arrangement is illustrated in the diagrams. In the same illustration is shown a triangle. On this triangle are shown the distance from the eye-piece to the film, the film speed, the altitude of the airplane above the ground, and the actual ground speed.

From this triangle it is clear that the ground speed bears the same ratio to the film speed as the altitude of the airplane bears to the eye-piece scale.

When, therefore, the film appears to the eye of the observer to be traveling just as fast as the ground, a simple arithmetical calculation will give the ground speed, provided the altitude is known.

In operation, the ground is observed through the eye-piece and the clockwork is started. There is then a difference between the apparent speed of the film and the rate at which the ground is moving across the prism. The eye-piece is then moved up or down until both speeds are equal; that is to say, until the film movement is synchronized with the apparent movement of the ground.

There are disadvantages inherent in the instrument. The altitude must be known and the land or water visible before readings can be made. Nevertheless, the meter is of obvious utility.

A German Automatic Pilot

WE have, in the United States, the Sperry Automatic Pilot, which has achieved remarkable success and is making rapid headway on the air lines. Thanks to the courtesy of *Flugsport* and *Flight*, we are able to give some information on the German Siemens Autopilot, the development of which has been a jealously guarded secret for several years.

The Autopilot is like the Sperry robot in design, in that it controls the airplane about all three axes. It differs from the American design in the fact that, although gyroscopes are used, they are not the sole basis of the corrections supplied by the working cylinders to the different control surfaces. The diagram shows the ingenious but intricate system employed. The thorough understanding of this mechanical brain might almost be the work of a lifetime, but our readers will perhaps be content with an outline.

The rudder control, though partially gyroscopic, receives its initial correction from a telecompass mounted far back in the fuselage of the aircraft. The float of the telecompass rests in an electrically conducting fluid, the fixed and movable electrodes being

(*Please turn to page* 278)

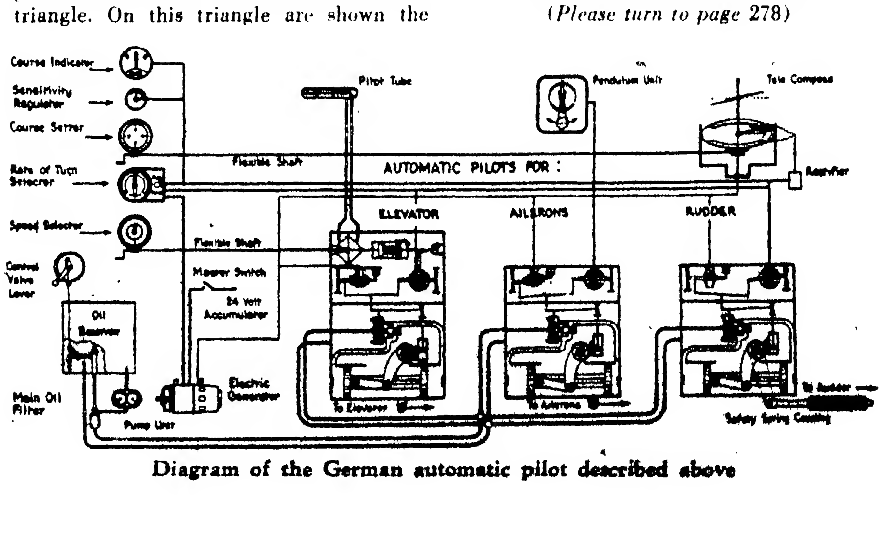


Diagram of the German automatic pilot described above

ELECTRIC HOTBEDS

Controlled Heat . . . Higher Percentage Of Germination . . . Better Quality Plants

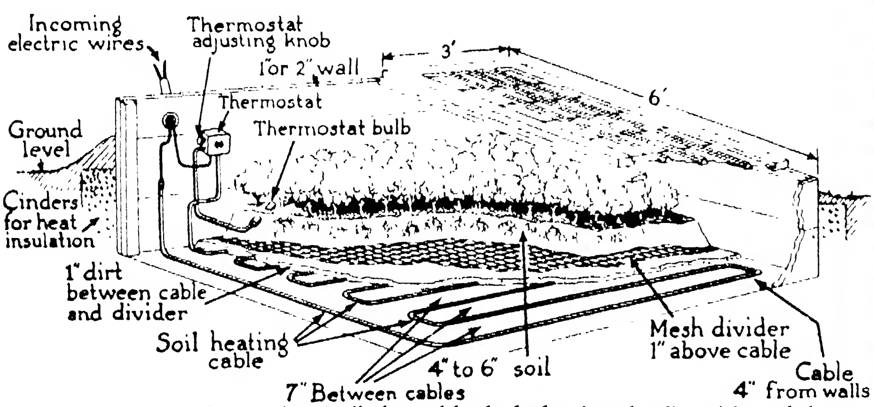
HEATING soil electrically, in order to stimulate plant growth, apparently originated in Norway, some years ago. In 1928, it was introduced into this country, and several seasons of experimentation have proved its advantages.

A system for electrically heating the soil in hotbeds and greenhouses that may be simply applied by any gardener, involves the use of a specially designed General Electric cable connected to a house-lighting circuit through a controlling thermostat. The cable is insulated so that there need be no fear of short-circuits, and is flexible enough to be adapted to almost any conceivable position in hotbed or greenhouse bench. The thermostat permits controlling the temperature so that it may be held at any point between 30 and 100 degrees.

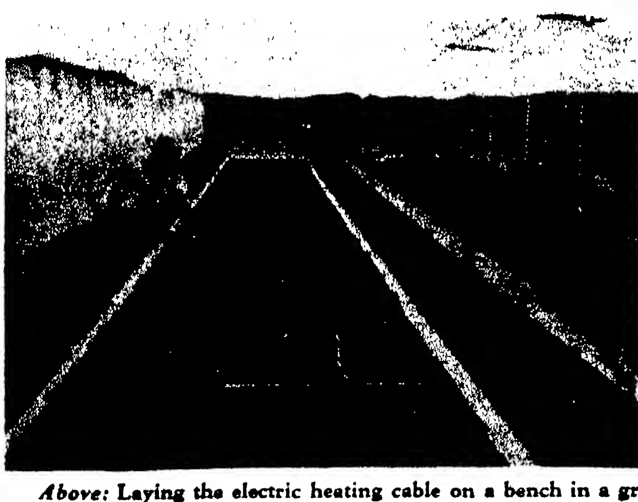
In the construction of hotbeds, the cable replaces the time-honored manure, and gives the advantages of controlled heat and freedom from the necessity of rebuilding the hotbed each year or between runs. The cable is laid in the bottom of the bed so that it is approximately three inches from the sides and has from four to eight inches between turns. It is then covered with an inch of soil, and a wire mesh divider laid in place to protect the cable. Over the divider is placed about five inches of rich soil. Authorities say that it is unnecessary to replace this top soil oftener than once every three or four years.

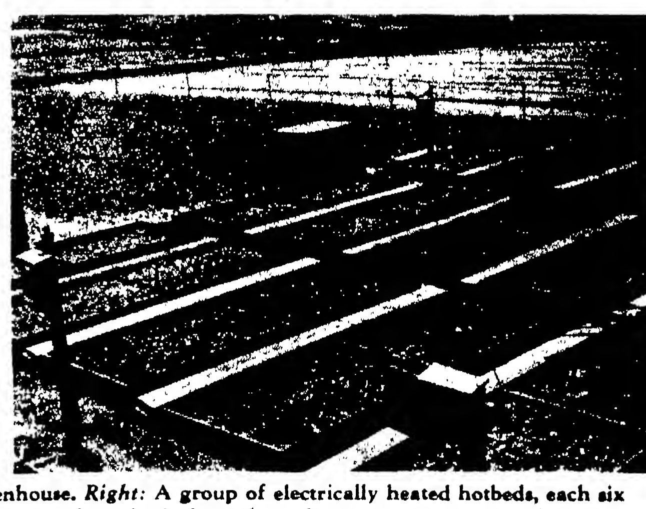
ELECTRIC soil heating has many implications other than for the amateur or home gardener. It permits the market gardener to place on the market many vegetables and flowers, weeks in advance of the regular crops. It results in quicker germination of seed, and in the growth of better root stocks and more sturdy plants.

Hydrangea slips 19 days old, grown in same greenhouse. Slip at left received ordinary heat. One at right was grown on a bench with the electric-cable bottom heating



A typical set-up for an electrically heated hotbed, showing the disposition of the heating cable, the controlling thermostat, and the wire mesh divider above cable





Above: **Laying the electric heating cable on a bench in a greenhouse.** ***Right:*** **A group of electrically heated hotbeds, each six by twelve feet, showing power supply lines.** ***Upper right:*** **Cable in a long hotbed, ready to be covered with an inch of soil**

EXPLORING PREHISTORIC GEORGIA

By A. R. KELLY, A.M., Ph.D.

Figure 1: **Mound A (in background), a house site, and exploratory trenching**

(Part 3. Conclusion)

IN a previous installment, mention was made of the fact that there were really two full-fledged archeological expeditions operating in central Georgia along the Ocmulgee River. Mounds A, C, and D, described before, belong to the Macon group of mounds surmounting the bluffs or plateau just east of the city of Macon, practically within the suburbs of the town.

In the low-lying river plain of the Ocmulgee, south and east of the city, begins the vast stretch of swamp and marshland continuing in an unbroken sweep along the river margins to join with the Georgia coast.

Archeological survey of the swamp tracts to date has led to the discovery of numerous small artificial hillocks of sand, black with decayed organic matter, rising two to seven feet above the tangled undergrowth. These are house mounds, small artificial elevations built by prehistoric swamp dwellers as the sites of timbered houses, thatched and partially walled with palmetto. Groups of seven to 25 of such house mounds are found together in orderly arranged clusters all along the Ocmulgee River and at the junctions with tributary creeks and smaller streams. Many of the house sites have been buried several feet beneath alluvial deposits within the last 150 or more years.

Where the river has changed its course recently, taking a new tangent through territory formerly virgin swamp, in the freshly profiled, river-cut banks, can be seen midden deposits, burials, pottery, exposed under three to five feet of river alluvium. At present no accurate check can be made of the approximate number of these villages and towns found in the swamps of central Georgia. Enough is known to state that the swamp population must have been considerable indeed, if these settlements may safely be regarded as having been more or less contemporaneously inhabited.

The archeological exploration of the swamp sites below Macon should really be the subject of another article. It will suffice now to indicate the nature of our discoveries in the initial excavations at Lamar village and mound site, a type site for the swamp peoples.

On the flood plain at Lamar, numerous undulating, hummocky rises dot the meadow, indicating the site of a house. Fortunately for the archeologist, man is not a particularly clean or tidy animal. Where he has lived the spot grows rank with luxurious vegetation, feeding upon organic wastes in midden and residence floor deposits. Away from the house hillocks the meadow lies flat and monotonous, with close-tufted, lighter colored grasses.

A general view of the early stage of archeological exploration can be had from Figure 1, showing excavations carried on simultaneously on one of the larger burial mounds (Mound A at Lamar) and a house site situated approximately 100 yards south of the mound. The flat expanse of the river plain, an overflow area widely covered with alluvium, extends on all sides of the village area, bounded everywhere by swamp growth. The problem of obtaining detailed photographs and adequate perspective of excavations undertaken on a flat flood plain was solved by the erection of a 40-foot observation tower.

MOUNDS A and B are conical, flat-topped mounds rising 20 to 25 feet above the meadow and surrounding village site. Both mounds probably had an aboriginal temple or important public building on top. The excavations in Mound A revealed that it was of composite structure. A primary mound was found beneath the upper mound. This core mound had a graded approach or ramp leading up to the summit from the north. Mound A was relatively much simpler than the five-in-one mosaic construction of Mound C in the Macon plateau group already described.

Mound B of the Lamar group is one of the most unusual mound structures in the United States (Figure 2). It is conical, truncate in form, with a spiral pathway ascending counterclockwise from the level of the plain to the summit—a Tower of Babel effect on a small scale. Preliminary archeological exploration, and known references to the customs of prehistoric tribes in the southeast, give strong support to the supposition that the summit was the site of important ceremonial observances, probably held within a more or less elaborate religious building. Actual trenching—profile studies of cross-sections—are contemplated in the near future at Mound B, to check these hypotheses.

In the Lamar plain, excavation of the hummocky rises marking house sites was a tedious and exacting task. Figure 3 shows a group of CWA workmen engaged in uncovering the floor of a house near Lamar Mound B. To the archeologist the supporting timbers and other charred remains in place give a clear picture of the type of house structure which once stood on this site.

A Mound with a Spiral Ramp . . . Hastily Abandoned Burning House . . . Largest Archeological Expedition in America . . . Similar Sites Abound

THE swamp dwellers built houses in the Ocmulgee marshes, not different from the rude arbor-like shelters constructed by the Seminoles in the Everglades of Florida today. The walls and roof were palmetto thatch, reeds and cane supplying the lathing upon which yellow river clay was daubed and chinked. Clay sod on top of the thatch made the roof impervious to rain. The walls may have been open or of purely temporary construction.

The charred house debris uncovered at the Lamar village indicates that the structure had been burned. When the central supporting timbers gave way the sod roof fell in, smothering the fire and thus preserving many architectural features which would otherwise have been reduced to ashes.

Figure 2: **Mound B, with its spiral ramp**

Every evidence of hasty abandonment of the burning house was found on the floor of the completely excavated house mound. Figure 4 shows the final stage of troweling, exposing the floor of the house as it had been left by the ancient Lamar villagers. Pottery, charred corn and beans, flint utensils, and other objects of ordinary domestic use were found in considerable quantities on the residence floor. Apparently the tenants had had no time to salvage anything before the danger of fire and destruction was upon them.

Burials within the Lamar swamp village were often made just outside the walls of the residences. In Figure 5 is shown a view of an extended burial just beyond the limits of the excavations uncovering the house site previously described. A refuse pit near the grave yielded many potsherds. This photograph shows another typical interment. Simple, flexed or contracted burials, in the areas of the village site occupation adjacent to house floors, contrast with the elaborate pit and log tomb crypts, secondary or bundle reburials, described in connection with Mound C of the Macon Group.

A difference in burial custom cannot be put forward as a consistent distinguishing trait between the villagers on the bluffs or plateau near Macon and the swamp dwellers (Lamar village), because primary, simple, flexed burials of Lamar type were found in the village on the plateau also. Mound C, the only true burial mound explored so far at Macon, provides an exception in mound structure, burial usages, and in other features not mentioned in this article.

The explorations carried on in central Georgia near Macon during the past season comprise perhaps the largest archeological expedition yet undertaken in America. The discoveries have been numerous and significant for the pioneer approach to a vast storehouse of prehistory in the southeastern United States.

Increasing evidence shows that the rivers and important tributary streams of the "deep south" and the lower Mississippi were densely populated. Ethnological information concerning the historic tribes in the region is confused by the complexity of tribal movements at the dawn of history (point of contact with white colonists, when written records and observations begin). Archeology reveals, in the initial major mound and village sites to be examined in a systematic way, that there was a long period of prehistoric occupation preceding the historic interval.

AT Macon we have strikingly exemplified in house structure, pottery design and technique of manufacture, economic activities supporting the contrasting types of village life led by the swamp dwellers and the older inhabitants on the bluffs and highlands—a consistent series of remains points to the existence of two distinct types of civilization. Archeological methods of establishing chronology, when applied to the problem in a tentative way, indicate that the highland near the fall line was settled at a remote period by people who grew large fields of corn, squash and beans; stored their produce in cache pits and granaries; built elaborate towns and villages on commanding sites, with some suggestions of fortifications around the peripheries; constructed large, flat-topped conical and pyramidal mounds as basic supporting structures for temples and important public buildings; and developed the textile, weaving, and pottery making arts to a high degree of excellence and variation in pattern.

Later—how much later cannot be determined as yet—came massed waves of

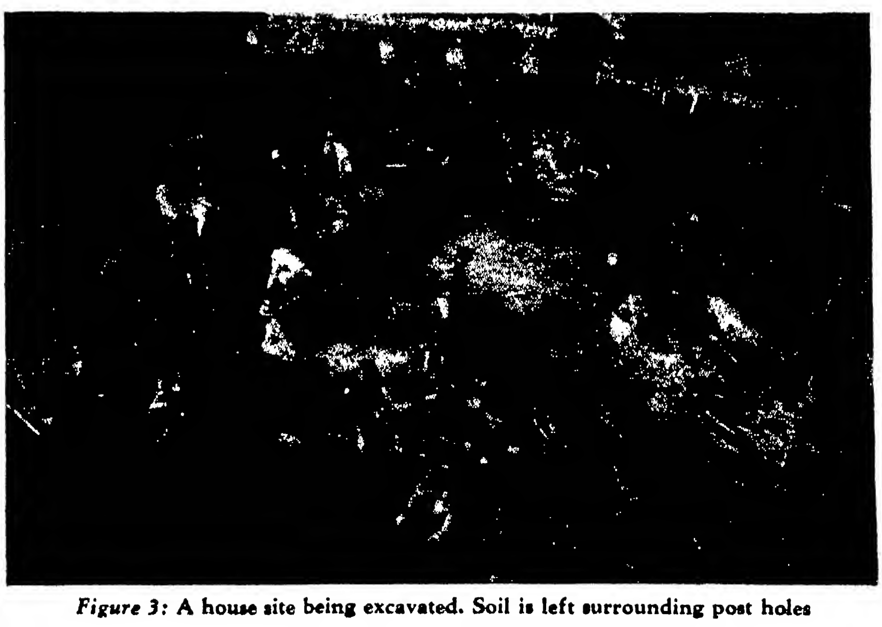


Figure 3: **A house site being excavated. Soil is left surrounding post holes**

Figure 4: During work this house site was protected by a tarpaulin roof

a different people, who seemed to prefer living in the low-lying, river-swept, malarious swamps. Their villages came to dot everywhere the river margin, extending back into the marshlands where important creeks and tributary drainage afforded opportunity for travel and contact by water transportation. They built artificial hillocks rising several feet above the swamp muck, high enough to protect the flimsy palmetto and reed huts from the swollen waters of the river. Dugout canoes, poled rather than paddled, were used to navigate the swamps.

Today the swamps south of Macon on the Ocmulgee look very much as they must have looked several hundred years ago. The palmetto ridges still bear mute evidences of the populous habitation of the Indian swamp dwellers, in the form of numerous small mounds overgrown with swamp vegetation, the ramps to the mounds often masked or completely covered by a mantle of river silt deposited in the last centuries.

SWAMPS and marshes would seem to many to be the least desirable human environment. A mountain fastness, even the desert, may have an attraction comprehensible to most tastes. The suspicion will probably arise that human groups would not voluntarily seek the swamp as a natural environment or preferred mode of life. If large populations have lived in them over long periods of time, the assumption might be made that they were refugee groups, seeking to escape the pressure of numerically more powerful peoples who had dispossessed them of more fertile areas.

The Seminoles living today in the Florida Everglades are refugees, historical remnants of Creek Indian tribes living in Georgia and Alabama during the 18th and early 19th Centuries. They have found sanctuary in their swamp homes, relatively free from interference by the white man and modern civilization.

One of the most striking characteristics of aboriginal Indian cultures in America is the inherent vitality, the fierce cultural conservatism, which led many tribes to seek the remote and least desirable territory where dominant groups would not molest them.

There are indications that this quality of early American culture is not new —not simply a phenomenon peculiar to the period of conflict and adjustment between the dispossessed Indian tribes and the European colonists. Shell mound deposits cover the coasts of Florida, Louisiana, Texas, and the north Pacific, which must have accumulated over long intervals, in some cases covering a span estimated as over 2000 or 3000 years. Archeological examination of these deposits indicates hardly a distinguishable variation in the pattern of living over such a long period of time. In California, ethnologists have found that at the time just preceding contact with Europeans the whole area of the coastal plains, the great inland valley and the enclosing mountain ranges and foothills, was inhabited by scores of tribal groups speaking languages as different from one another as English from Chinese. The territorial bounds of these divergent tribes were immediately contiguous. Yet the tribal patterns of culture remained intact, little changed or affected, for many centuries. The average Indian grew up, lived and died, within narrowly circumscribed village and tribal boundaries, seldom going more than 15 to 20 miles from home during a lifetime. Such cultural self-sufficiency is inconceivable to a person living in a modern community surrounded by so many media of communications and social intercourse, all tending to give the texture of life a familiar feel wherever one may go.

THE exploration of these swamp villages and towns in central Georgia has only just begun. Reliable information indicates that similar sites are to be found along the margins of other rivers in the state and in the heart of the vast, unexplored Great Swamp on the borders of Florida and Georgia, the Okefenokee.

The 71st session of Congress passed the Vinson Bill, providing for the establishment of a national monument on the Ocmulgee at Macon. Surveys are under way at present to map the archeological and historical sites to be comprised within the monument area. It may confidently be expected that soon thousands of visitors will visit the sites recently explored in central Georgia, and that the interest created by the establishment of the monument may help to bring about a more complete exploration of the southeastern archeological province.

Figure 5: **A skeleton found near a house site. Note also potsherds at right**

STREAMLINING IN NATURE

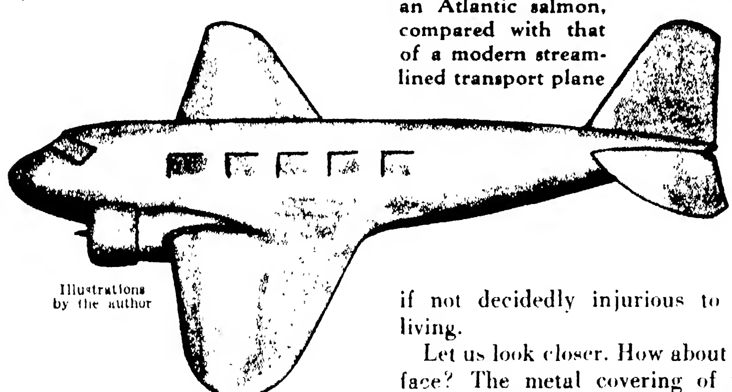
How Man May Learn From Nature . . . The Streamlined Salmon . . . Long Over-Seas Flights of Birds . . . Small Details of Vast Importance

By RAY HOLLAND, JR.

IT is common knowledge that fish and birds are streamlined. For that matter, all earthly creatures that move rapidly are, by necessity, well shaped for speed. Insects and land mammals are not exceptions. The interesting thing, however, is not this generality of attention to air and water resistance, but the meticulous sort of work, and the delicate care, which are exhibited by natural streamlining. Close observation of how the avoidable portion of fluid resistance is kept small in nature gives the naval architect or the aircraft designer something to think about. If he believes that his particular design is the ultimate, he should stop to consider the forms found in nature.

But isn't our modern airplane exceptionally well streamlined? To be sure. We can not deny it. Its even surface, its smooth curves from nose to tail, its blending transformation from wing to fuselage, its freedom from holes and projections, its full robust form; all of these things make for speed. It is an object of beauty, an artistic triumph as well as an engineering success. It represents the apex of streamlining achievement by man. Where is its parallel in nature?

The first random choice of a natural parallel of the super-speed airplane in the matter of streamlining is the Atlantic salmon (*Salmo salar*). At a glance it appears that the form of the salmon could serve as the fuselage for the transport plane. We notice a slight difference. The airplane fuselage has an elongated section amidships. This is for the cabin, an economic necessity in a passenger plane. Also, there is a discontinuity of form at the nose of the plane to provide for the flat windows through which the pilot sees. Either of these trivial appearing modifications would be highly bothersome to a salmon, if not decidedly injurious to a good living.



The speed-form of an Atlantic salmon, compared with that of a modern streamlined transport plane

Illustrations by the author

Let us look closer. How about the surface? The metal covering of the airplane fuselage, upon close scrutiny, reveals thousands of rivet heads. More often than otherwise they are not indented into the surface and flattened smooth, but stand out full and round in the breeze. The trailing and side edges of dural sheets, put on so as to lap over each other, stand exposed adjacent to the lines of rivets. Probably you think: "Utterly trivial." But what does the salmon say? He is covered with very small scales. These scales also have their edges. But the edges are not exposed. The entire fish is covered with a slime which is exceedingly slippery. The water flowing past him comes in contact with nothing but the essence of smoothness.

The salmon is not a perfect streamline form, by any means. He has a nose which seems too pointed. This, among other purposes, is for digging a trench in the pebble covered stream bed during spawning, to receive the eggs and milt of the parent fish. Also he seems too long in proportion to his depth and beam. The answer to this undoubtedly is that he must use his body for propulsion. It is not merely a shape evolved to have a minimum of resistance in the water. It is provided with the necessary fins for propulsion, maneuverability, and stability.

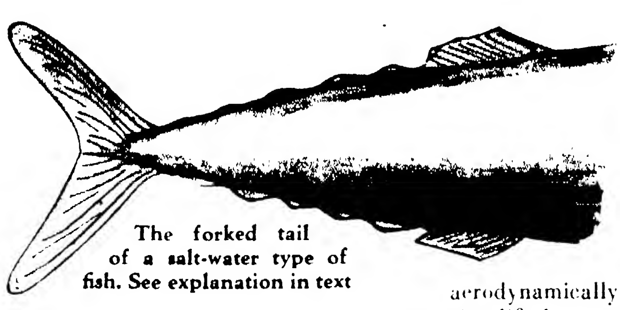
The airplane has fins projecting from its body; the tail surfaces and perhaps we should include the wings. On a few of the newer machines the filleting of these surfaces into the body is of the same general form as that seen on the salmon. This blending of surfaces is one of the fine points of good streamlining. On the salmon an observer is not able to say where the body becomes the fin and vice versa, the change is so subtle. This degree of filleting has rarely been accomplished in airplanes. It is a phase of design which engineers are appreciating more all the time.

AMONG the fishes, the salmon is probably not the best streamlined. There are several salt water varieties which could vie for that honor. Their very existence in the open sea depends upon their speed, in avoiding being eaten, and in catching their food. In general, the bodies of these fast swimmers have a cross-section which is quite full, approaching the circular. Their bodies taper almost to a point instead of to an edge. Their narrow forked tails represent a very efficient utilization of surface. The whole arrangement points to a different propulsive mechanism, a different tail action. Instead of a side-to-side sweeping motion, it is adapted to a twisting motion about the long axis of the fish. Such a type of propulsion removes the necessity for the large side area required by the other type, and leaves the body free to take a more high-

ly specialized low-drag form. It is in this respect that they are able to boast a better shape than the salmon.

From a practical standpoint we may well ask whether such painstaking streamlining is really worthwhile. Does it produce results? It is very difficult to find out how much resistance a salmon actually has. The moment the fish is removed from the water its covering of slime commences to dry, altering its form appreciably. The eyes become sunken, the fins curl up and split, and the mouth and gills remain open. A shrinkage accompanies this drying which usually draws up the head and tail somewhat. If the fish is lying on a flat surface it will take the form of that surface on one side and be bowed excessively on the other. In addition to these defects of form, the fins, the exact positions of which are variable, are no longer properly aligned. It would be necessary to avoid these and other difficulties in order to preserve the exact form of the salmon for use as a model.

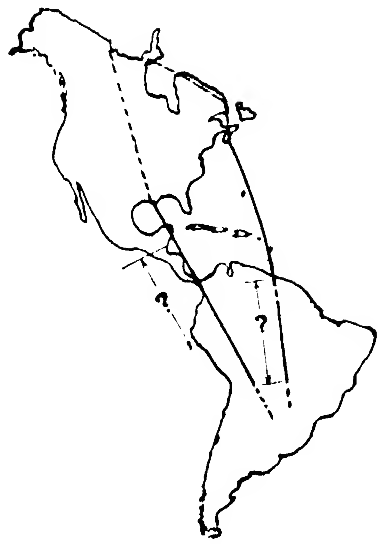
WITH birds the problem is even more difficult. The living bird literally feels the flow of air over its body. It rarely has the same form over two successive seconds. Each feather is located precisely for the airflow existing at any particular instant. Practically the entire surface of a bird is variable.



The forked tail of a salt-water type of fish. See explanation in text

The wings are a complex folding mechanism, with any number of possible positions which might be chosen for testing. Each feather has its particular part to play, and a large number of them require control by the bird. Even the feathers which compose the down depend upon the temperature and condition of the skin for their exact positions. Birds are very fussy about having their feathers properly arranged.

The form of a flying bird depends upon the velocity and direction of the airflow around it. Most of the wing feathers deflect in flight, and, what is important, the deflection depends not only upon the flexibility of the feathers themselves, but also upon the condition of tendons and muscles in the wing and breast. It is hardly reasonable to hope that a dead bird or a mounted bird will be correct in these deflections, even if its feathers could be arranged perfectly to start with. A slight error is all that is needed



Sketch showing the migration routes of the golden plover. Solid line flown non-stop except in bad weather. Doubtful portions shown

to make test results invalid, because the quantities being measured are small.

These examples show what the scientific investigator is confronted with when he attempts to learn quantitatively just how well streamlined a bird or fish actually is. However, since we are not satisfied with the conclusions of the eye in superficial comparisons, we seek substantial evidence that natural streamlining has been effective in producing results. How are we going to be sure?

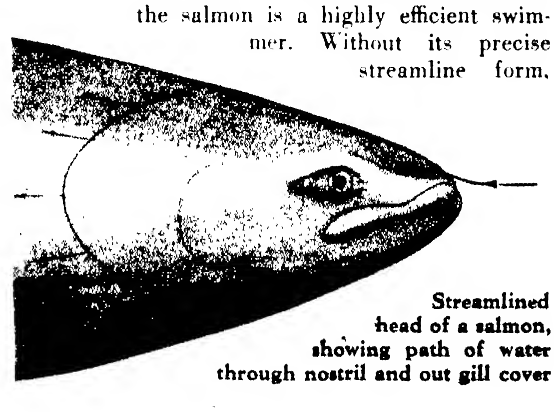
Omitting the case of the soaring bird, which depends so much on the ability of the bird to feel out rising air currents, and which, aerodynamically, is a specialized and simplified case, there is a convincing example which may be cited.

Each fall the golden plovers concentrate in Nova Scotia and fly from there to South America! Only very adverse conditions put them down along our coast or in Bermuda, or at any of the other emergency stopping points along the way. After another hop to the pampas of Argentina, the birds take wing in the spring for Texas, where they arrive in poor condition. That they are not fat is not to be wondered at. From Texas they proceed easily back to the Arctic. This sounds like a tall tale, but the Pacific plover bears out the story by flying annually from Alaska to Hawaii and on south to Palmyra and the Low Archipelego. And then they go back again. Moreover, there is nothing in their food which is obtainable on the high seas. Neither is the bird a swimmer. Its feet are not webbed. It is equipped only to alight on land.

Since birds have a limited energy supply, and since they actually perform these very long flights, we must conclude that their efficiency of flight is remarkably high. This efficiency probably comes from more than one source. They undoubtedly use the winds to advantage, and possibly cover some portion of the distance riding the upward currents, but that is not the whole story. The consistent migratory passage of these birds seems to indicate without much doubt that their air resistance is no greater than is absolutely necessary. Aerodynamics and instincts go hand-in-hand to make these flights possible, and even so, they seem almost unbelievable.

To get to the second point in evidence, that natural streamlining is highly effective, we return to the Atlantic salmon. For many years a discussion has been waged concerning the fresh water feeding of this fish, or the lack thereof. The scientific status of the question at present is that the Atlantic salmon does *no* feeding in fresh water, although some few men find it difficult to believe that the fish might not on rare occasions eat just a little bit. The amount of food it does take in fresh water is negligible.

HERE is the story of its spawning trip. The fish begin to run up the rivers in the spring and continue to come in all summer, usually working up to the coldest water which is in the headwaters and in the deep pools. Spawning occurs in the fall. In some streams the fish return to the ocean before the rivers freeze over. Usually the fish stay upstream in the fresh water through the winter and go out again in the spring after the ice leaves. Many of the fish live a full year without food! And are they active? They are continuously swimming in very rapid rivers. They leap falls. They jump two or three feet clear of the water, apparently just for the joy of it. They swim thousands of miles, measured by the water which flows past them; and all of this on an unimpressive appearing supply of fat! After making all the allowances we can think of, we must still conclude that the salmon is a highly efficient swimmer. Without its precise streamline form,



Streamlined head of a salmon, showing path of water through nostril and out gill cover

especially in the tiny details, its life would be a physical impossibility.

What are some of these small details of streamlining which make it possible for the salmon to do what it does? Let us start our observations at the nose of the fish. The comparatively small mouth, when closed, presents a neatly rounded symmetrical prow. The nostrils are two small circular holes. Behind each of them there is a comparatively abrupt rise, to iron out any eddying caused by the nostril holes. The eyes are reminiscent of streamlined wheel fairing on airplanes, with the eye itself corresponding to the side of the wheel. The gill covers fit so closely and smoothly that it is difficult to slide a fingernail under them to lift them open. They are a natural counterpart of the N.A.C.A. cowling.

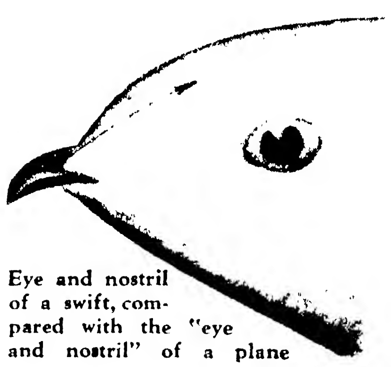
THE pectoral fins lie flush with the surface of the body during fast swimming. For slow maneuvering they act as paddles or feathering vanes. The dorsal fin may be held up stiff for a maximum of area when that is required. For fast swimming, however, the spines lean toward the rear to reduce the area and also eliminate the hollows between successive spines. The most interesting are the pelvic fins. They must be moved during fast swimming, and so they must be well filleted in different positions. The solution provided for this by Nature is a small movable fillet which lies smoothly between the fin and the body of the fish no matter what relative positions they take. Not a single item has been overlooked to allow this fish to slide through the water with a minimum of effort.

How about birds? What are their fine points of streamlining? The bird's body is exceptionally well formed for speed. It differs from that of the fish in that it is not used for propulsion. Consequently it may be quite short and fat. The cross-sectional shape is always full and round. And because the bird has such a highly developed, flexible, and capable control system, it does not require the long tail which the airplane has for purposes of stability. The only departures from the pure streamline form are the head, wings, and tail. The numerous fins of the fish are not needed.

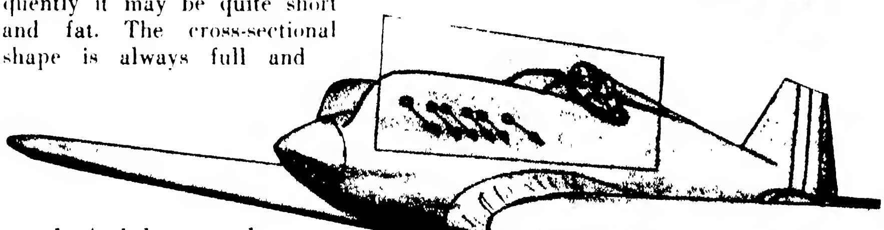
The head is quite often included in the pure streamline form of the bird's body proper, as in the case of swifts, swallows, and many others. In other birds such as ducks, geese, and cranes, a long neck separates the head from the body. With such an arrangement any disturbance in the air caused by the head is ironed out by the passage of the body, so that the combination has very little more resistance than that of the body alone.

The head and tail of all birds are very neatly faired into the body. The legs, of course, are drawn up into the surface. In many forms of flight the tail has little to do, and consequently is folded so as to be barely visible. The entire arrangement is an extremely simplified form. The thick thatching of resilient feathers makes an abrupt change of curvature an impossibility. Where the wings fold down against the body you might expect to find a sharp angle. It is prevented by a group of long thin feathers whose sole function it is to fillet that intersection of wing and body on the under side.

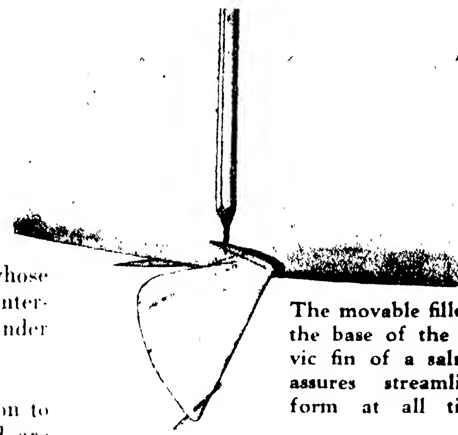
YOU may say that, in comparison to its size, the feathers of a bird are not smooth, that the surface is composed of small interlocking barbules, and that under magnification hollow spaces could be seen. Feathers of some birds are smoother than those of others. However, if you pluck any feather at random from a bird, an observer is able to tell, by close examination, exactly what position the feather occupied with reference to the direction of airflow. He does this by discerning the fine trailing edge of the feather which transfers the continuity of surface to the next feather in line immediately to its rear. Only by magnification is this information obtainable, the edges are so delicate and perfect. He can also tell which part of the feather is actually exposed. It is the translucent nature of the horny structure of feathers that is likely to cause the belief that the structure is coarser than it really is.



Eye and nostril of a swift, compared with the "eye and nostril" of a plane



As a final example of the careful streamlining in nature, have you ever thought of how a bird inhales and exhales the air it uses for breathing, without upsetting the flow over its body? The swift does it by drawing the air into its nostrils from the rear and exhausting it toward the rear, tangent to the surface of its head. The air passage is situated so that it does not open normal to the surface as it appears to, but the nostrils actually face backward. Even this precaution is not enough. The head and body lie immediately to the rear to catch any disturbance, however slight, which might have been caused. What is true for the swift is probably true for other fast flying birds. What a contrast this offers to the exhaust stacks of most of our airplanes! We, too, would show the same degree of respect for the unchanging demands of the air, if we had been battling our way through it for ages instead of for mere years.



The movable fillet at the base of the pelvic fin of a salmon assures streamlined form at all times

WE are getting down to fine points. That is what makes good streamlining. One totally insignificant appearing source of interference or disturbance may increase the resistance of an object many times over. By the sure process of evolution very effective results have been accomplished. To the aeronautical engineer it is an object lesson in the value of thoroughness and care. Apparently Nature knows more about compounding forms to produce a low overall drag than man will know for some time. Only recently has the effect of one air form on another been seriously considered. Improvement has been rapid, but there is still a long way to go.

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Parts of the foregoing article may appear to be controversial in nature. Both the author and the editor will be glad to hear from readers who may feel that they have something to add to the discussion, or who may disagree with the conclusions drawn.

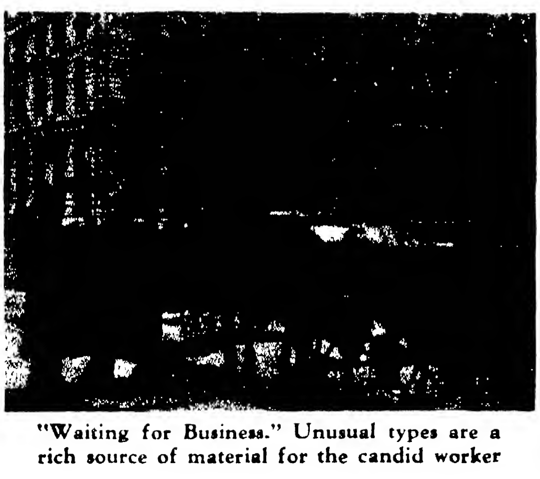
CANDID PHOTOGRAPHY

By JACOB DESCHIN

THE making of candid snapshots—photography of people without their knowledge—is undoubtedly one of the most exciting and, when successful, one of the most satisfying, phases of contemporary photography. While candid work is definitely within the province of the miniature camera, unposed pictures of persons unaware of being photographed were and still are being made with larger cameras, especially the reflex type. The superiority of the small camera for this type of work, however, is obvious; its compactness, ready accessibility, ease of concealment just before and during exposure, are advantages so patent that no one would think of debating the subject.

"In the Subway." An interesting character study taken underground. Exposure made at 1/20 of a second with a diaphragm opening of f/2

Perhaps equaling the value of a really good candid shot is the splendid training in the perception of picture material which the cameraman gets in watching for those fleeting incidents, expressions, situations, which once lost are gone forever. The man who essays "candid shooting" and finds it congenial to his tastes soon becomes a sleuth after human interest; the interesting face, the story-telling situation, the thousand and one fleeting little comedies and tragedies of life are his constant study. His camera, well hidden, is always with him. Spotting a likely subject, he approaches cautiously, outwardly nonchalant but inwardly all concentration, and whips his camera out and returns it to his pocket again all within a few seconds. When there is time, as in the case of a subject giving every sign of "staying a while," he takes the opportunity to wait for the best moment, for that moment in a million when his subject assumes just the right expression and just the right gesture that makes all the difference in the world between a prosaic portrait and the lively unposed snapshot that has all the poetry of life in it.



"Waiting for Business." Unusual types are a rich source of material for the candid worker

The true candid cameraman is the most self-effacing chap on earth; the more he is ignored, the less he is observed, the better he likes it. Among the array of miniature cameras, accessories and wonder-working films and developing solutions that produce prints which would have been impossible only a few years ago, he wants for but one thing—some magic formula by which he might make himself invisible at will.

Lacking such a formula, however, the exigencies of his "now-you-see-me-now-you-don't" career have taught him many subterfuges, in which he is ably abetted by a number of "gadgets." One of the most useful of these is the so-called angle-view finder, a device which by means of mirrors enables the photographer to give the impression of aiming at something down the street while actually taking the picture of a subject standing at right angles to the photographer's apparent vision. A variation of this, where a low viewpoint is desired, is to point this finder straight down to the floor or sidewalk and become ostensibly immersed in the examination of some mechanical problem of the camera itself.

VALUABLE as such devices have proved on many occasions, it has been the experience of the writer that some elderly persons, who comprise one of the richest fields for candid shots and are, at the same time, one of the most difficult to get, appear to sense that they are being photographed and immediately turn their backs or get up and go away. Success in such difficult cases is often achieved by turning one's back on the subject and operating the camera from under the left armpit, viewing the subject either in a reflecting view finder or, in the case of reflex outfits, the ground glass. Nevertheless, the angle-view finder has gotten "candid" workers out of many a "hot spot" and one man has filled a whole book with pictures of city life taken with its help.

No mechanical aids ever made, though in many cases they spell the difference between getting a picture and losing it, will work to full advantage without intelligence, resourcefulness and alertness on the part of the man behind the camera. An excellent precaution being used by many candid workers to great advantage is the pre-

"Hands at the Free Lunch Counter." A night shot taken through a window. 1/10 of a second, diaphragm opening f/2

setting of the miniature camera lens (which is usually of 2-inch focal length) for day-shots to $f/9$ and for night shots to the full aperture, and setting the focusing scale at 12 feet. For day shots this will bring into focus all objects from 8½ feet to a little over 20 feet, which gives the cameraman a guessing range of more than a dozen feet. With this set-up he is ready at a moment's notice and has simply to whip the camera out, snap and go (or run, if necessary!)

Night shots will generally require a wide-open lens; since the greater the aperture the shallower is the depth of focus, the guessing-range at night would be approximately two feet. In view of this, night photographers who find it difficult to judge distances so closely without the use of a range-finder will need to focus each time. Against this disadvantage, however, is the benefit of darkness, which permits the cameraman to be less conspicuous than he would be in the same situation in broad daylight. Stationing himself in a doorway or some deep shadow, he will often find, if he works fast, that he can focus and shoot without being observed. Another method is to focus on some point where he expects "action" and wait until his subjects appear, when he can shoot at his leisure by pulling the camera out of his pocket or from under his coat at the psychological moment.

Elusive Subjects Tax the Advanced Amateur Photographer's Ingenuity . . . Theater Pictures Possible . . . Miniature Cameras Solve Problems

THERE is nothing so disappointing as a batch of dull and worthless negatives which have been shot at random. Patience, therefore, and still more patience, should be the candid photographer's constant watchword. At night, if trying for people in motion, wait for slow movement; slow speeds are as essential for the comparatively poor light available for night work as extreme speeds are for pictures in the full blaze of daylight. In all candid photography see that the light falls on the subject's face, that the "action" or situation has human interest or pictorial value and that the general arrangement or composition is pleasing. There is not always time to watch for the last, but this point can often be taken care of on the enlarging easel in the darkroom.

"A Study in Attention." A hawker demonstrates; a candid camera catches expressions

Theater photography, which includes the taking of snapshots during the actual performance of a play, vaudeville show, concert, movie, or other type of indoor entertainment, is allied to candid night work only in the sense that both require working under comparatively difficult light conditions for snapshots and consequently call for miniature cameras equipped with very fast lenses and slow shutter speeds and loaded with the super-sensitive type of panchromatic films. In vaudeville, indoor sporting events, at the circus, and similar situations, where strong spotlights are used, "daylight speeds" are very often necessary, but the ultra-fast lenses have been found equal to the task even at a speed of 1/500 of a second at $f/2$. Shutter speeds of 1/100 and 1/200 with $f/1.5$ and and $f/2$ lenses have been found adequate for most dancing and acrobatic stunts. By watching for those split-second moments when active performers seem to have halted in their motion it is sometimes possible to use much slower speeds.

"At the Theater." Taken from the third row in the balcony. Exposure 1/10 of a second at $f/2$

THE taking of pictures while a play is in full progress has become so popular that it is now a regular branch of photography and a few workers who have specialized in it have made reputations for themselves in the production of so-called "performance photographs" which find their way into magazines in preference to the regularly posed type. In recent months there has also been a tendency to display such pictures in front of theaters.

In this kind of work it is necessary to get as near to the stage as possible, about the fourth or fifth row orchestra or in a box, although in theaters where the balcony is not too far from the stage, a seat in the front row of the balcony may be suitable. An aisle seat is a good vantage point, and care must be taken to shoot over the heads of people in the row in front. It is useless to try to take pictures in anything but white light. Colored or dim lights will register nothing. Speeds of 1/20th to 1/40th of a second are often sufficient, but in many scenes it will be necessary to use speeds as low as 1/10th or 1/5th. For the slower speeds watch for situations with the least movement and hold the camera absolutely still, using the nose to steady it. Resting your back firmly against the seat will help to reduce vibration of the camera to a minimum, and insure sharp negatives.

While the photographer may not wish to make enlargements of all the pictures he takes of both the candid and entertainment variety, he will find it very satisfying to make contact prints of all the worth-while negatives and mount them in albums. Records of contemporary life as he personally responds to it will in retrospect delight both himself and his friends; records of the plays and other entertainments he has seen will be constant reminders of pleasant moments at the theater.

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The list of representative miniature cameras available in the United States, mentioned in these pages before, is still available and will be mailed on request. Three cent stamp, please. A list of up-to-date books on photography, invaluable to the advanced amateur photographer, will also be sent to interested parties, when the request is accompanied by a stamp to cover mailing.—The Editor.

ELECTRICITY'S PLACE IN RAILROADING

Improve Schedules . . . More Power . . . Solves Problems of Heavy Traffic . . . Less Maintenance for Electric Locomotive, but Greater Fixed Charges

By G. I. WRIGHT
Chief Electrical Engineer, The Reading Co., and C. R. R. of New Jersey

THIS is the second of three independently written articles on railroad motive power. Last month the case for the steam locomotive was discussed by William C. Dickerman, President, American Locomotive Company. Next month, the Diesel side of the picture will be presented by George W. Codrington, President, Winton Engine Company.—*The Editor*

RAILROAD transportation is undergoing rapid change. Many think we are on the threshold of a new era in which basic alterations in methods and equipment will be adopted.

Where does electric traction fit into this picture and what has it accomplished? What are its advantages and its relation to the requirements of the future?

The first railroad electrification in this country was that of the Baltimore & Ohio's Baltimore Tunnel in 1895. As electrification has been extended, the electric locomotive has been made larger and improved and in 1935 there will be about 750 of them in use in this country, or less than 1.5 percent of the total locomotives in use. Also there are 2600 electric multiple-unit cars, which is 5.6 percent of the total passenger cars in use. In Europe these percentages are larger. However, these electric locomotives and cars have been chosen to handle the most difficult operating problems the railroads have had to cope with. It is of interest to touch on these accomplishments.

On the Virginian, three Mallet type steam locomotives formerly were required to handle 5600-ton coal trains up extended lengths of 2 percent grade at seven miles per hour. Under winter conditions it was necessary to reduce this load materially. Since electrification, two electric locomotives haul 6000-ton trains regardless of weather conditions, at 14 miles per hour up the same grades. The two electric engines provide 10,000 horsepower at the rims of the driving wheels against 4500 horsepower for the three steam engines, yet the total weight of the electrics is less.

THE Norfolk & Western has a similar operation, and the C. M. & St. Paul, and the Great Northern haul heavier freight and passenger trains at materially higher speeds over the Rockies than formerly. In the east, we are all familiar with the electrified trains operating under the rivers at New York, which make it possible to land passengers in the heart of the city. The Great Northern operates its electric trains through an eight-mile tunnel.

Electrification has been called on to solve problems of heavy traffic. On the Pennsylvania's New York-Washington section, where 639 passenger and 47 freight trains per day are handled under present depressed business conditions, electrification has been chosen to provide faster schedules, higher reliability of arrival, and greater track capacity. In this service, they will employ 4600 horsepower electric passenger locomotives weighing approximately 230 tons each. To accomplish the same schedule as this electric locomotive with a given train, a steam locomotive, due to its greater weight and poorer accelerating characteristics, would require about 25 percent more horsepower and would weigh over 550 tons.

For suburban traffic with frequent stops, the multiple-unit electric car is the only known means of providing the rapid acceleration necessary to maintain high schedule speeds. The ease of turning these trains at terminals, the ability to operate without a fireman, and the flexibility of train make-up provided, all add to their advantages and make possible large savings in operating costs. The Long Island; New York Central; Delaware, Lackawanna & Western; Illinois Central; and the Pennsylvania and Reading are examples of their use.

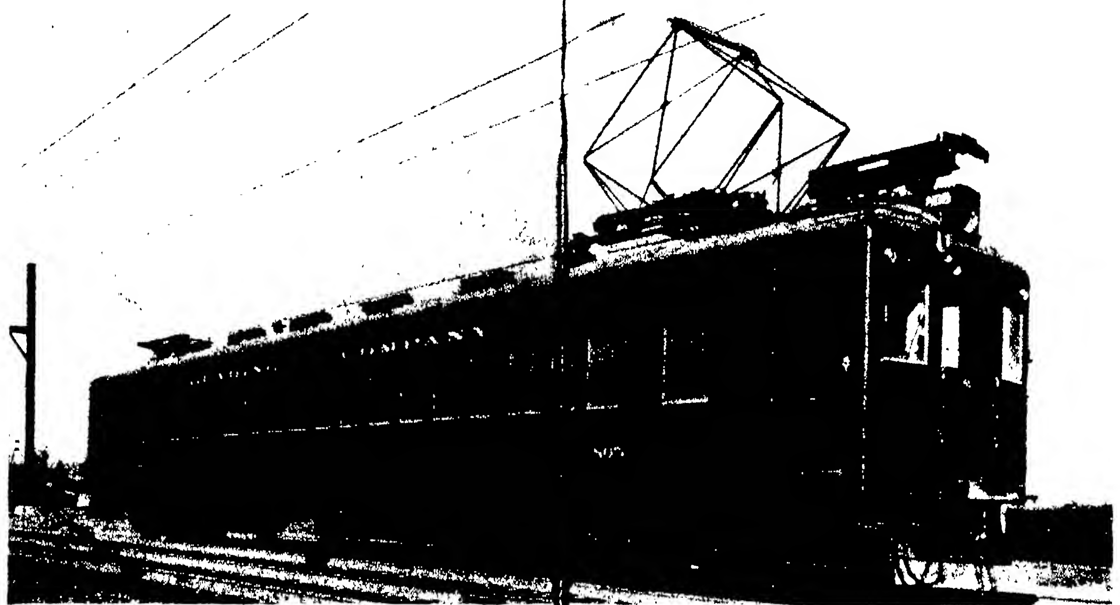
THE principal advantage of electric motive power for railroads lies in the fact that the electric locomotive or car receives its power from a central power plant through the overhead contact wire and is not limited in its power output as is the case with the self-contained power plant of the steam and oil-electric locomotive. The electric motors can be overloaded for short periods and this enables the locomotive to accelerate at maximum rates to quite high speeds, and to maintain high speeds on grades. This is of great importance to the railroad operator, enabling him to shorten schedules without the necessity of increasing maximum speeds or raising speed restrictions necessitated by operating conditions at various points.

Now let us consider the economics of electric traction. A railroad may be likened to a manufacturing plant the product of which is transportation. Entering into this process are materials, labor, and the necessary tools. By far the most important tool used is the locomotive, because it is the plant's power.

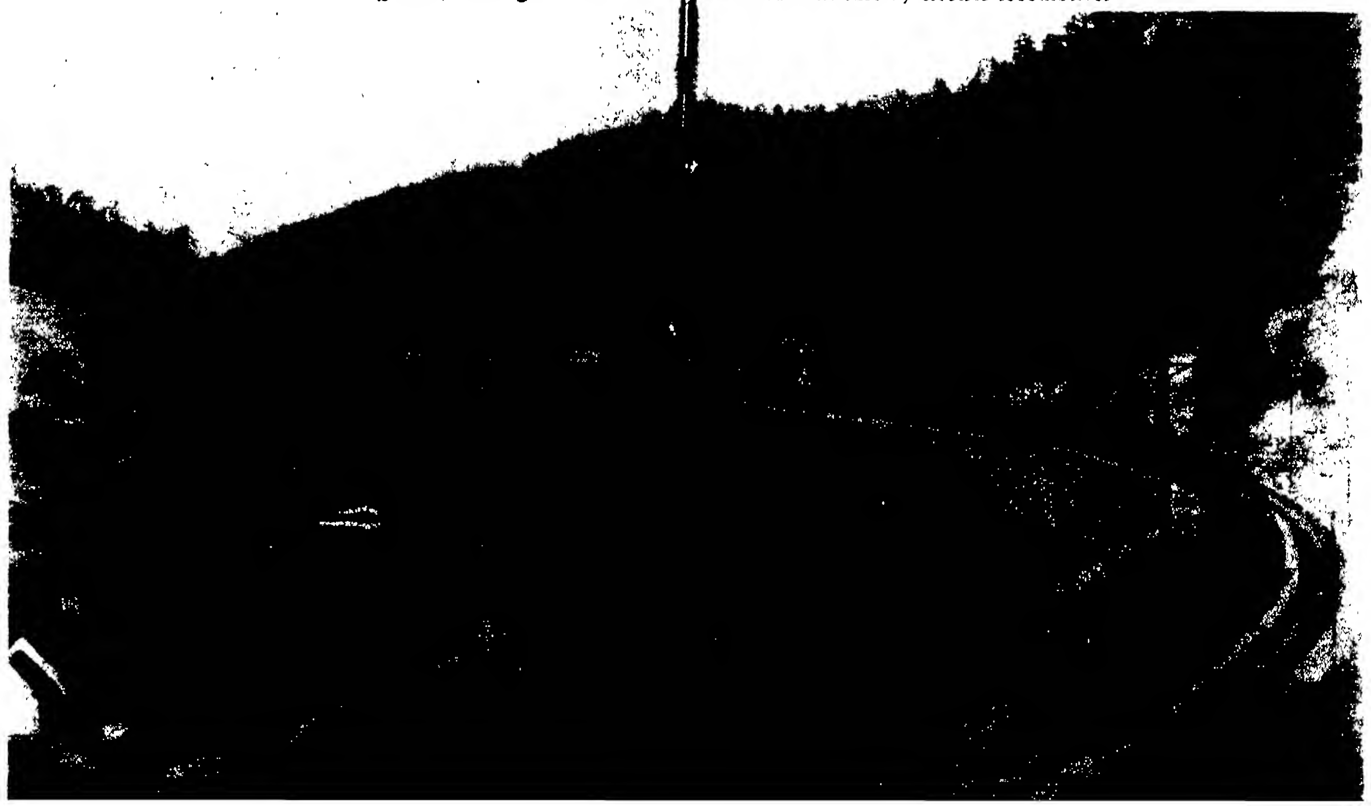
The electric locomotive can be maintained for much less than other types due to absence of oil engines, boilers, fireboxes, brick work, steam auxiliaries, and reciprocating parts. It does not require attention at the end of each run for coaling, watering, oiling, cleaning fires, and the like, and is, therefore, available a greater percentage of the time.

As to thermal efficiency, the electric locomotive using power generated in large, efficient, central power plants, and including all the losses from the power plant to the electric locomotive wheels, can do the same work with one half of the coal required for a modern steam locomotive.

Due to all this, the electric locomotive can be operated in similar service for from 50 to 65 percent of the cost of the steam locomotive and multiple unit trains effect even greater savings.



For short-line and commuter service the electric car unit is most efficient



On the Virginian, where great coal trains are handled with ease by electric locomotives

THE electric locomotive, however, requires electric power to be delivered to it from a central power plant by means of a contact system, with substations built along the railroad. The investment in the distribution lines and substations will amount to 25,000 dollars to 50,000 dollars per single track mile. Interest, depreciation, and maintenance on this investment will amount to from 2500 dollars to 5000 dollars per single track mile per year.

The economic picture is now apparent. A better tool in the electric locomotive is available. It, however, costs more than its counterpart, the steam locomotive. It also requires other facilities, the investment in which results in annual charges, irrespective of the density of the traffic. With this better tool, considerable savings in the cost of hauling a train-mile or a ton-mile can be made. If there is not sufficient traffic so that the operating savings will more than offset the increased fixed charges, electrification will not pay. If, however, heavy traffic is to be handled, the operating savings will be sufficient to pay the increased fixed charges and make the electrification a financial success.

What of the future? Can electric motive power take care of the high-speed trains now coming into use? High speeds require more horsepower which increases rapidly above 70 miles per hour. To increase the speed of a 500-foot train from 70 to 100 miles per hour requires two and one half times the power. At 125 miles per hour it requires about five times the power. The higher ratio of power to weight then becomes of increasing importance. A recent study of this whole subject presented before the New York Railroad Club concludes that the advantages and economics of electrification are greater at the higher speeds with both conventional and light-weight streamlined trains.

As this is written, the Pennsylvania Railroad has just placed in operation the most extensive electrification in the world. It should serve as a transportation laboratory and a yardstick as to what can be accomplished with electricity in mass transportation.

The operation of the first train carrying Government and railroad officials made the 135-mile trip from Philadelphia to Washington in 1 hour and 50 minutes with a five-minute stop in Baltimore, breaking the record set in 1927 by a locomotive and baggage car.

WHEN this project was started it was stated, in terms that outline concisely the case for electrification, that: "It is expected to reduce eventually the number of freight trains by 50 percent for a given car movement, and thus to provide a 100 percent increase in capacity as far as freight movement is concerned. In the case of passenger trains, it is expected to eliminate all double-heading and most of the second sections, which will result in greater comfort, better service, and increased capacity of the line. Freight trains will be kept moving all the time possible while on the road; there will be no stops for fuel or water, and as few as possible for yarding. Engine divisions will be lengthened where possible, and the make-up of trains will be so arranged as to obviate reclassification at intermediate yards. The overall speed of freight trains may thus be raised to a point closely approximating the maximum speed of freight equipment. All traffic may be moved at considerably increased speed, and—within the limits of safe operation—it is expected that this will provide great satisfaction to shipper and traveler alike, in addition to rewarding the railway by greatly improving the capacity and efficiency of its existing transportation system."

INDUSTRIAL DIE CAST PRODUCTS

CUTTING CASTING COSTS

Die Casting of Many Metal Products . . . Least Expensive . . . Process Improved . . . Replaces Other Processes . . . Die Design Advanced . . . Future

By PHILIP H. SMITH

TODAY you can hardly escape making use of a die casting, no matter what your calling. If you drive an automobile, die castings function for you at key points. If you write on a typewriter, they serve you without your knowledge, and when you turn the lock in your door or help Junior play with his streamlined electric train, here, too, they are present. Die castings go to make up all manner of office and home equipment devices, though you might not be able to recognize them because they are so often concealed beneath a coat of metal plating, enamel, or lacquer.

Die casting now affords one of the least expensive methods of making a large number of metal articles, and of making them quicker and better than in any other way.

This is a fact which signals an about-face for the die casting industry. The troubles which toppled the business into relative obscurity after enjoying a mild boom some 15 years ago are a matter of history, for intensive research has led to a revamping of practice and to an ultimate achievement which will astound all but the best informed engineers and production men.

Die castings are being used for hundreds of different metal articles, yet they have not won through to their final position in the production world. They have penetrated a few industries pretty thoroughly, notably the automobile industry, but the full sweep of their possibilities is still in the making. They have had to live down an unsavory reputation and that has taken years of painstaking effort by a few faithful exponents, first to make die castings absolutely reliable and then to convince the production world of the accomplished fact.

Die casting is pretty widely understood to involve the forcing of liquid metal into a die to harden to form. This remains casting practice today. The difference between the old and the new method is wholly one of establishing standards for the metal alloys used, perfecting casting technique, and developing greater skill in the designing of dies. Three factors then—materials, conditions, and technique—are responsible for giving reliability to die cast articles.

IN the transformation of the die casting industry, the science of alloying has been carried to great lengths, with the resultant knowledge of what can and can not be done by grouping metals in specific amounts. There has also been an increase made in casting pressures so that now 500 to 2000 pounds per square inch is used as contrasted to the former 100 to 500 pounds. Higher pressures make a denser product and consequently a stronger one. Finally, casting speeds have been raised. It is now possible to cast articles at the rate of 150 to 300 an hour and in some exceptional instances

rates as high as 1000 per hour have been reached.

Die castings can and do replace some sand castings, stampings, screw-machine products, and forgings. It is a fact that die castings are stronger than sand castings and come from the die with better surface finish. Even with fairly expensive dies and small quantity output, material savings have been made over identical sand castings. It is also a fact that savings have been made in the replacement of stampings because complex forms can be produced in a single operation, whereas similar stamped forms might require many dies and subsequent multiplication of stamping and assembling operations.

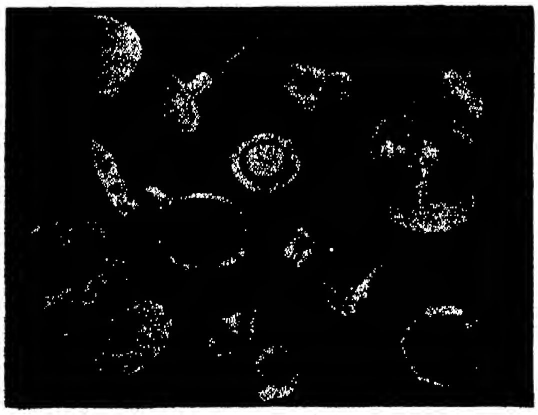
Saving in fabricating, machining, and assembling is the advantage that probably appeals most to the prospective user of die castings. Imagine the possibilities that have been opened up by the everyday success in turning out products requiring complex coring. It means that articles with intricate form can be turned out with a single shot of the casting machine. Such castings can be made with very close dimensional limits, the actual degree of accuracy to which they can be held varying in inverse ratio to the melting point of the alloy being cast. They can combine thick and thin walls, and if the product does not come out of the die with finished surface it requires only a slight grinding or buffing to obtain it. There is no assembly work requiring soldering or welding; usually no machining, except to remove small fins; and there is no scrap metal in the usual sense, since any metal left over is used over again immediately.

A CARBURETER body provides an excellent example of what can be done with die casting. Here a complex form is cast to very close limits, as it must be if the delicate mechanism it is to house is to function properly, and a saving is made in material costs, machining, and assembly. Another example is afforded by the tripod of a motion picture camera. In this instance seven different castings are made with a single die, thus saving on die costs as well as operations since all castings are made with a single shot of the casting machine.

Two extremes in die casting: a 50 by 22 inch, 33-pound windshield complete in one casting, and a slide fastener with 26 castings per inch

Industry has a wide latitude in choice of materials for die casting and there is a further spread of choice in the variety of alloys possible with each base metal. The ultimate selection bases upon a consideration of physical properties, weight, corrosion resistance, dimensional tolerance, aging and dimensional changes, toxic effect, machining properties, surface finish, and the final cost per cast piece. At the present time casters need spend little time experimenting with alloys because research of the past few years has determined the definite alloying proportions to give satisfactory results under controlled conditions. Prolonged investigation by the American Society for Testing Materials, the Society of Automotive Engineers, and leading producers of the raw metals have led to standardization of practice so that the "guess" is largely eliminated.

Casting practice—that is, the conditions under which casting is carried on—has been very much improved in recent years. Casters now know more about the flow of molten metal under pressure, the effect of cooling jackets and the size of gates and overflows, which must be understood to produce reliable articles of commerce. The improvement is reflected in the higher pressures and greater speeds under which operations are now conducted as well as by the products themselves.



Aluminum die castings for aircraft: light weight, strong, tough, and corrosion resistant

Die designing, too, has been advanced, perhaps fully as much as the science of alloys and casting, but it still remains a matter of individual skill. Granted that a suitable alloy is available, there is always to be considered in relation to each new article, the problem of devising a die that will handle the job expeditiously. If the article to be made is complex in form there arises the problem of coring and the question whether or not a single casting or multiple casting must be used. Even redesign of the product itself may be considered since the consolidation of several parts into one would eliminate machining and assembling operations. This all has a bearing upon costs, and possible savings depend in large measure upon the ingenuity of the designer.

DESIGNERS have shown extraordinary ingenuity in recent years as anyone can see by examining the castings now entering into articles for the consumer. Their energies are by no means spent. There are still many sand castings and stampings that can be replaced by die castings when designers get to them, or rather when the problems are brought to them.

Dainty cigarette lighters are die cast effectively in mass production

The following examples show what has been done and indicate some possibilities.

One manufacturer producing a trolley wheel and contact holder found he could replace the bronze wheel and cast iron holder with zinc castings and get identical performance from the finished product at an 85 percent saving in cost. A clock maker substituted a die cast clock case for a stamping to save weight. He got a 15 percent saving in weight but also a more rigid case and at a saving of 32 percent in cost. A third manufacturer, a producer of high-priced automobiles, cut the cost of a cowl bar from 40 dollars

THIS article is the sixth of a monthly series of "word pictures" of different industrial fields by Mr. Smith. Others that have gone before covered: Diesels; Plastics; Cemented Carbides; Packaging; and Paints.

Mr. Smith's next article will appear in July, as he will defer in June to Secretary of Commerce Daniel C. Roper, who writes on Southern Industry.—*The Editor.*

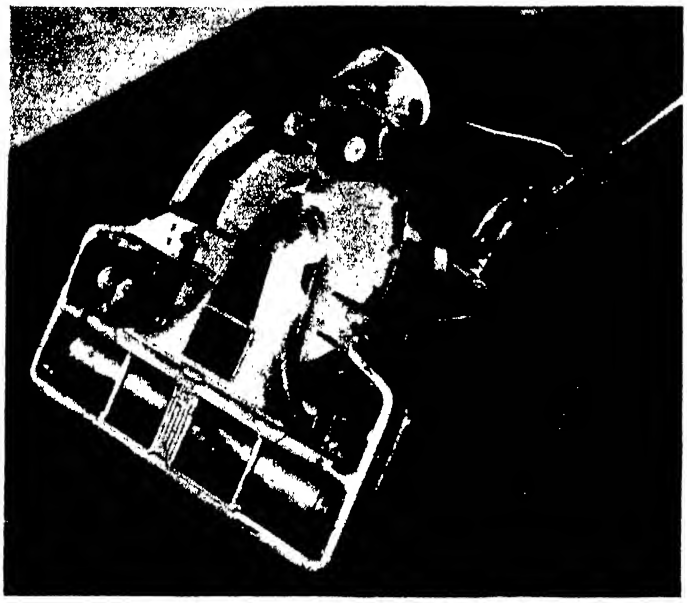
to 20 dollars by using a zinc alloy casting in place of a bronze sand casting.

Examples of this nature might be enumerated for several pages, although dollar and cents savings could only be intimated, for the advantages manufacturers have gained by substituting die castings for other metal forms quickly become trade secrets and are not translated into figures for the benefit of competitors. That die castings have come into broad use in industry and that more industries are adopting them is evidence *per se* that a better product can be had or that cash savings can be made—usually both. If further proof is needed it is only necessary to point to the automotive industry as the largest single user of die castings. This is the industry which considers performance and cost reduction more closely than any other and adopts with greatest promptness the means to achieve them effectively.

AT the beginning of this article it was stated that the full sweep of die casting possibilities was still in the making, and it is no exaggeration. It is hard to believe that the ultimate has been reached in the science of alloying or casting, but assuming for the moment that no further progress is made, there could still be an expansion of die casting. It requires only the utilization of the possibilities which have been uncovered so quietly in recent years. As yet applications have been largely of the obvious type, leaving real opportunities for ingenuity to work along new lines. Quite recently some unique applications have been tried and their success points the road to others. A year ago, for example, no caster would have thought to attempt die casting slide fasteners, but it is practical. The metal is cast right on the fabric, the "teeth" being shot on to it hot from the casting machine and, perhaps even more astonishing, the "teeth" are plated while on the fabric with whatever metal style decrees.

Die cast slide fasteners, exhibiting 26 castings to the inch of length, and windshield frames 50 by 22 inches, made in a single casting weighing 33 pounds, represent the two extremes of die casting and they afford the best possible illustration of the present range of this metal handling process.

Die castings do not have to be used alone. They can be combined with other materials. This constitutes an entire field of practice which has as yet hardly been scratched. By the ingenious use of inserts which may be metallic or non-metallic, characteristics can be given to a casting which are not native to it and so broaden the uses to which it can be put. The insertion of steel blades in die cast table knives is illustrative. Then, too, in instances where casting is precluded by complexity of design, it often can be made feasible if the form is simplified and the omitted part or parts be supplied by an insert, such as a stamping.



Complex housing of a vacuum cleaner that was die cast of aluminum. The various smaller parts are die cast of zinc alloy

In combination with non-metallic materials like porcelain, wood, or plastics, decorative effects can be obtained and this creates opportunities for the product engineer. Cast water-faucet handles with porcelain "hot" and "cold" inserts are being used; so are wooden door knobs in conjunction with die cast building hardware. Often the shrinkage of the cast metal upon cooling is sufficient to hold the inserts rigidly, and if it isn't, a simple groove serves the purpose.

The range of die casting use is dictated somewhat by available casting alloys. Some alloys produce articles stronger than ordinary gray cast iron; some approach mild steel in strength and practically all alloys make articles stronger than sand castings. Tensile strength may run from 30,000 to 60,000 pounds per square inch, depending on the alloy, and transverse and impact strengths are usually very high. But a consideration of the various alloys will make this clearer and will explain why castings are coming into wider use for certain purposes.

The casting alloys are always made of zinc, aluminum, tin, lead, copper, or magnesium; that is, these are the dominant metals. They are also used as alloys together with several other metals. Zinc is now by far the most commonly used of casting metals and alloyed with it in very small amounts are copper, aluminum, and magnesium. The principal advantages of zinc are its low cost, its low casting temperature (which means that low cost steel dies can be used), ease of machining, its good physical properties, corrosion resistance adequate for most uses, high production rate, and the simplicity with which surface treatments can be applied.

EARLY failures of zinc alloy die castings were due chiefly to inter-granular corrosion. This trouble has been traced to the presence of tin and lead as impurities and it has been overcome by using zinc of highest purity and alloying with virgin metals. In effect, this means a closer control of alloy content. It is also characteristic of zinc that it shrinks slightly after casting, though in some types of alloys it grows again. Unless a product must be held to very close dimensions this peculiarity does not have to be considered, but if dimensional accuracy is important, an artificial aging process can be employed and machining delayed until the process is completed. There is finally the characteristic of losing impact strength at very low temperatures. If it were a serious deficiency, however, we would not be likely to find zinc alloy castings being used for such articles as automobile exterior hardware.

When zinc castings are used for such parts as carbureter bodies, no surface finish is needed other than that imparted by the die, but where appearance is highly important, as with many fittings and accessories, castings are buffed and then plated. Plated die castings are to be found in windshield frames, lamp brackets, door handles, and horns; but even when plating is involved the casting process represents a simplification in manufacture. An automobile horn, for example, can be cast in one piece whereas former practice consisted of drawing

from sheet metal and then soldering to a casting for assembly; a windshield frame needs only buffing and plating as contrasted with the grinding and polishing prior to the plating of a sand cast frame. All this means substantial cost saving.

Zinc die castings are used extensively as parts for household and office appliances, for hardware, light machines, and parts for electrical goods. But when parts are to come in contact with food having acidity, or must withstand marked corrosive action, or be light in weight, aluminum alloys take precedence over zinc.

ALUMINUM is second only to zinc in importance as a casting metal, but an age that stresses weight reduction presages a rise to greater prominence. In addition to the qualities enumerated above, aluminum has greater tolerance for impurities and it can be polished so that no surface plating is required to enhance appearance, although an anodizing process in which the casting serves as the anode can be used effectively.

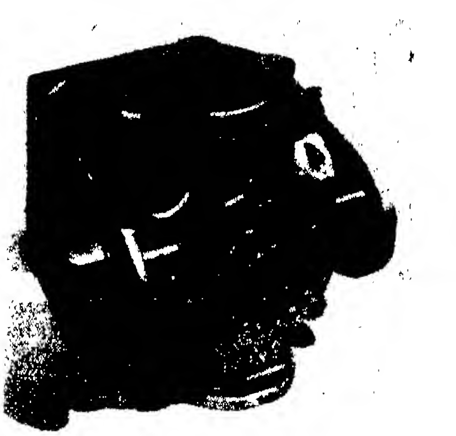
Die castings of aluminum alloys find wide application for automotive parts, but principally where light weight is a factor, as in airplane construction. In household equipment aluminum die castings are playing an ever wider rôle. They go into vacuum cleaners to lighten weight, and they are used in cooking and mixing machines where there is contact with food. This metal, which is alloyed with copper, silicon, and nickel, has a greater dimensional permanence than zinc and so enters into castings for instruments and recording devices such as counters, clocks, and meters.

Copper, as a base metal for casting, now has limited use but a high potential one. It is not the least expensive metal to use and because of its higher melting point more care and expense must go into the making of dies. Machines which are suitable for casting zinc and aluminum are not wholly satisfactory for copper alloys, and there are greater difficulties to be overcome in the casting process. Still, copper has a place in the die casting business. Where strength, ductility, hardness, and corrosion resistance are to be desired, copper is the choice of metals and there are many applications requiring just these qualities.

Recent research in copper, which has led to the development of several alloys, promises to give casters some new copper combinations with higher strength and resistance to fatigue, but as yet these alloys of wide potential use have not reached the stage where they may be put to practical use.

Magnesium is the newest of the casting metals. It has not had very long in which to prove its worth, but even so, its extreme light weight has given it a unique position in the field of casting and we can look to hear more from it. Aluminum and manganese are alloying metals and a variety of alloys are being made by varying the relative proportion of these two metals. Magnesium makes a very stable alloy and one easy to machine. In most characteristics the alloys approach those of aluminum very closely. The finished casting does not lend itself well to electro-plating, but it can be painted or lacquered.

Stringing along at the end of the list of metals are tin and lead. The first was once the most widely used of all die casting metals because of its very low melting point, but with the ironing out of difficulties attached to other alloys it has sunk to relative insignificance. Tin casts with extreme dimensional accuracy, hence it serves well for number wheels and odometer parts. It is also found in food and dairying equipment where all toxic effect must be avoided. Lead, likewise, casts with ease and it has the property of resisting chemical action, but it lacks the strength and hardness needed for most applications. Battery parts are sometimes cast in lead.



Pump body showing the complex design possible with die casting

In the last analysis the future of die casting rests heavily upon the skill of the die maker. Even with the most suitable alloys the finished casting will not be satisfactory unless the designer is well versed in practice. He must understand the action of metal upon cooling in order to avoid strains which might lead to cracking of the casting when in service. He must know just where strengthening ribs must be used to prevent distortion. In short, when everything possible has been done to perfect alloys and casting machinery, there is still required the indispensable ingredient of designing skill to make casting successful; success meaning not only production of a serviceable article, but production at lower cost than by any other means.

ACTUALLY the progress of die casting is to be gaged to a high degree by the advancing skill of die makers since the metallurgical and mechanical factors have been brought to a high state of development. This, in turn, demands close co-operation between designer and caster. What we are now seeing is the building up of a technique, and it is this very technique which makes the future of die casting both limited and unlimited and so fascinating. It leaves much to the imagination—the very same quality which has built up die casting to its present state of accomplishment and which promises to carry it to the winning of new frontiers.

Several parts of a door lock cast in a single die, finished at left, and as they come from the die at right, still connected by the "dead" metal to be cut away later

Photographs courtesy: Aluminum Company of America, Crown Fastener Corporation, and New Jersey Zinc Company.

THE AMATEUR AND HIS MICROSCOPE—XV

THRILLS FROM A HOME-MADE POLARIZER

By PHILIP R. TARR

(In Two Parts. Part I)

OF the innumerable thrilling and educational observations that may be made with an ordinary microscope, few can compare, either in beauty or fascination, with those made with polarized light. An unlimited field may be opened by adding the necessary polarizing equipment to your microscope. Brilliant-colored crystals, crystal structure, plant structure, stress effects, and many other sights are revealed in a dazzling array of color, or in beautiful, apparently luminous, form against a

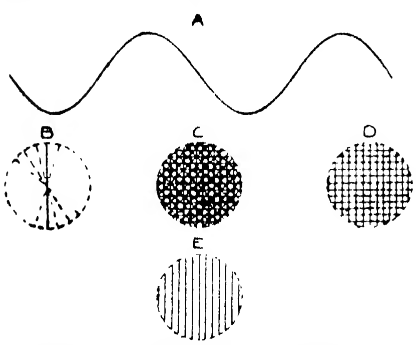


Figure 1: **Diagrams for suggesting the behavior of a beam of light**

practically black, or colored, background.

Ordinarily, polarized light is obtained by the use of prohibitively expensive equipment such as Nicol prisms. These cost from 25 dollars up, and most of us cannot afford them. However, other methods are available which, although not precise, will for all practical purposes produce equally fine results. The apparatus may be constructed from odds and ends for less than two dollars.

Before describing the apparatus let us become acquainted with a few fundamental principles concerning polarized light. In the following explanation a compromise has been made between technical accuracy and explanatory clearness.

Suppose we examine Figure 1 and imagine we can see an individual wave form of light. Referring to *A* and remembering that this wave form is not perceptible as such to the human eye, we see a side view. If we could view this from a point on its path of travel, the wave form shown at *A* would appear as in *B*, in which the dotted circle represents the boundary of a fictitious beam of light. Light is thought to be composed of an infinite number of such wave forms, whose planes of vibration lie in all possible directions, which are ever changing until polarized. If we imagine them, from our point of view, again within the path of the light beam, they should appear as represented diagrammatically in *C*, in which the straight lines illustrate the changing planes.

If we now place certain transparent materials (*e.g.*, calcite) in the beam represented by *C*, we find that a peculiar thing happens. The light, which entered the substance vibrating in all directions, comes out vibrating in only two directions, always at right angles to each other. In addition, the rays which are composed of these two sets of vibrations emerge at different angles, thereby forming two rays. These rays are known as "plane polarized light."

These two rays are radically different in their behavior. One of them, in passing through transparent material such as Iceland spar, is bent or refracted the same amount as ordinary light, and is therefore called the ordinary ray. The other ray is refracted in a different manner from ordinary light and is called the extraordinary ray. In microscope practice all of the rays of one kind are reflected to one side and thrown out of the field of vision. The remaining rays vibrate in only one plane and are represented by *E*.

Suppose we pass the remaining polarized rays through another polarizing device, set in the same relative position as the first. Under these conditions the polarized rays will be passed through the second polarizer (which is now termed the "analyzer") without change. When observed, as for example through a microscope, the field will be light.

If, however, the second polarizing device, or analyzer, is turned at right angles to the first, that is, the polarizer, the polarized rays projected on the analyzer become the rays which are discarded by reflection, and the field will be dark.

For all intermediate positions of the analyzer between light and dark fields, proportionate amounts of light are transmitted.

ANOTHER method of polarizing light is available, and is the method used in the apparatus to be described. Light reflected at a certain angle from the surface of glass is plane polarized. The transmitted light, or light which passes through the glass at this angle, is also plane polarized with its planes of vibration at right angles to those of the reflected light. This method is known as "polarization by reflection," or as "transmission," depending upon which light is used.

While there are several methods available by which polarizing apparatus may be attached to the microscope, a commonly used arrangement consists of placing the polarizing device immediately below the stage and the analyzing device within, or immediately below,

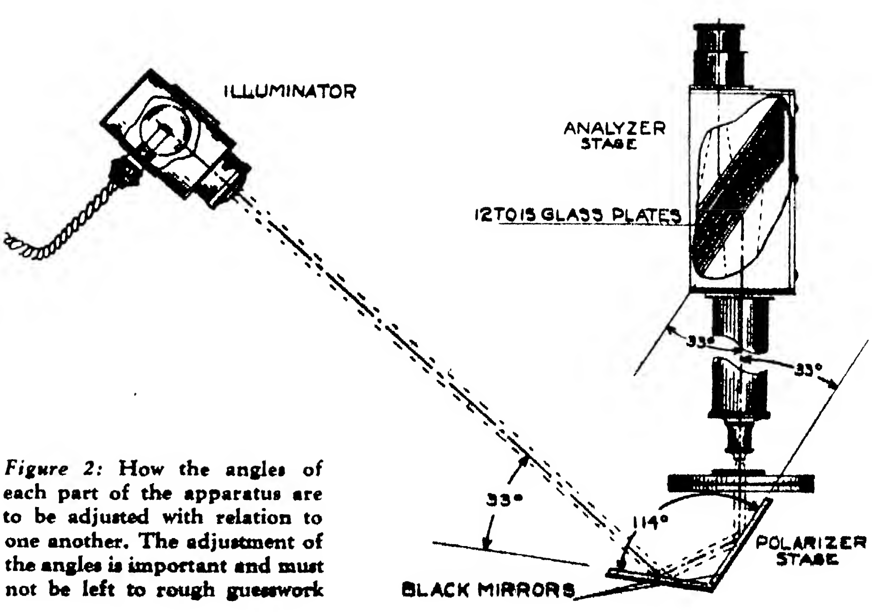


Figure 2: **How the angles of each part of the apparatus are to be adjusted with relation to one another. The adjustment of the angles is important and must not be left to rough guesswork**

An Unlimited Field for Experimentation and Fun . . . Gorgeous Display of Colors Difficult to Exaggerate . . . Cost, Less than Two Dollars

the eyepiece. They are called, respectively, polarizer and analyzer.

As an example, when we place a slide containing a few crystals of oxalic acid upon the stage, polarized white light from the polarizer passes through and around the crystals into the analyzer, thence to the eye. With the analyzer adjusted to the dark field position, the crystals, which are themselves polarizing materials, produce ordinary and extraordinary rays. Inasmuch as these two rays travel through the crystal at different speeds, being refracted or bent differently, they will be "out of step" when they emerge, and when recombined in the analyzer they will produce an effect seen as color. Different portions of the crystals will vary in thickness, consequently varying the color effects within each crystal. The whole effect will be seen as apparently luminous crystals in a myriad of color on a dark background.

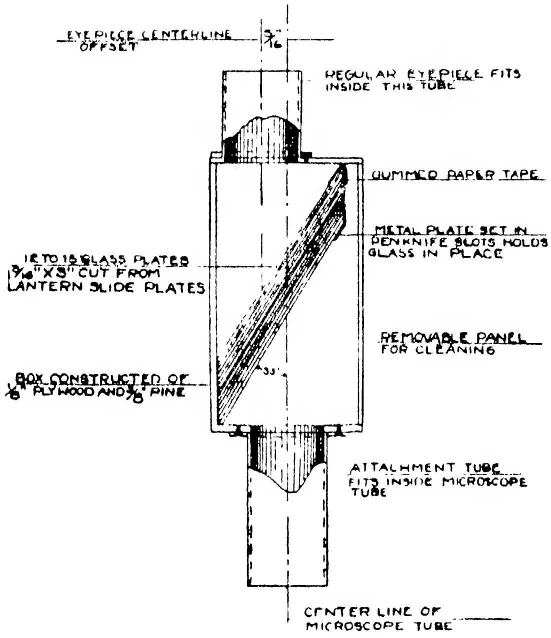


Figure 3: **The analyzer. Note 33 degree angle**

Materials which produce such effects are called "double refractive." The preparation of a few crystals will be explained later; in the meantime let us see how the necessary apparatus may be constructed.

Figure 2 shows the general arrangement of apparatus necessary, and the fundamental requirements for making it. Very few details are given, since the construction is relatively simple, and by making minor alterations the equipment can be fitted to any ordinary microscope.

Particular attention should be given to all indicated angles, especially during preliminary experiments, after which slight readjustment of any or all angles may improve results.

THE polarizer stage consists of two black mirrors. These may be made from lantern slide cover glasses, cut to two-inch squares and painted on the back with a thin mixture of lampblack in shellac. A single thickness of black photographic paper may be cemented over the lampblack layer with an additional coat of thin shellac. The mirrors are finally fastened to a metal plate, bent to the proper angle, as shown in Figures 2 and 4. (A thin melted layer of sealing wax was used by the author for fastening the mirror to the bent plate, although a layer of cloth dipped in shellac would do just as well.) Figures 4 and 5 show how the assembled black mirrors may be fastened over the regular microscope illuminator mirror with brass clips.

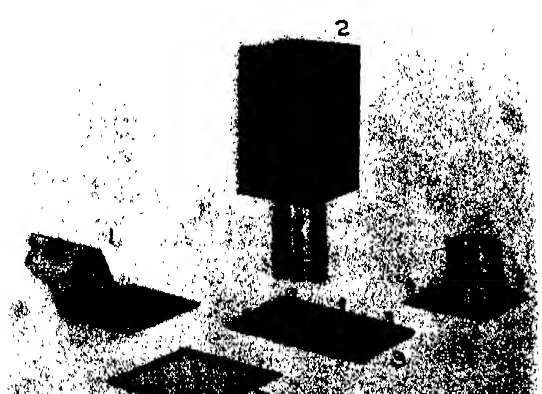


Figure 4: **The entire polarizing equipment, ready for final assembly. 1: Black mirrors. 2: Analyzer box with glass plates in place. 3: Removable door for analyzer. 4: Eyepiece tube fitted to plywood cover. 5: Mica plate**

Figure 5: **The completed polarizing apparatus installed and ready for use. When using the apparatus it is best to shade the stage from stray light with a cardboard shield**

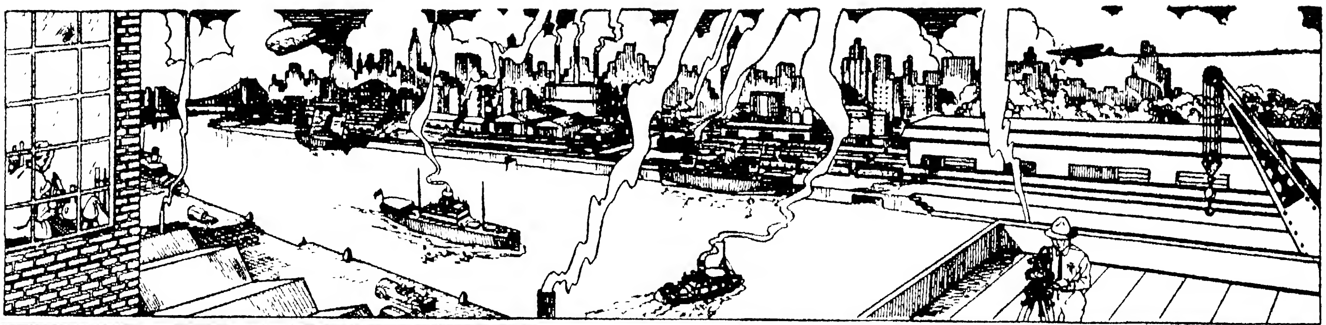
The analyzer, Figures 3 and 4, is constructed of miscellaneous pieces of pine and plywood.

The quality of the image seen through the analyzer is controlled largely by the quality and flatness of the glass used. Ordinary glass is practically useless, although lantern slide cover glasses are quite satisfactory. These may be obtained from any photographic supply house at a cost of 50 to 60 cents. They should be taken to a glazier for cutting, where a diamond-pointed cutting tool may be used, so as to obtain smooth, even edges. Scratching of the surface may be avoided by cutting each individual plate on a small piece of fresh blotting paper, using a new piece for each glass plate.

Before finally assembling the glass plates in the analyzer box, each should be cleaned thoroughly by washing in a hot solution of tri-sodium-phosphate, one ounce to one quart of water. Dry on a clean, lint-free, linen towel, blowing each plate free of dust as it is dropped into place. A small strip of gummed paper lapped over the last plate, as shown in Figure 3, will hold them all in place.

After arranging the glass plates it will be noticed that an image of the ends of the plates nearest the observer is reflected toward the center of the pile when viewed from either end of the analyzer assembly. To overcome this effect the tubes are offset, as shown in the drawing. This arrangement, in addition to placing the reflected image outside the field of vision, also maintains a centrally located field when the analyzer is turned.

The apparatus is ready for use when assembled with all angles adjusted as shown in Figure 5, and its use will be explained in the next installment.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
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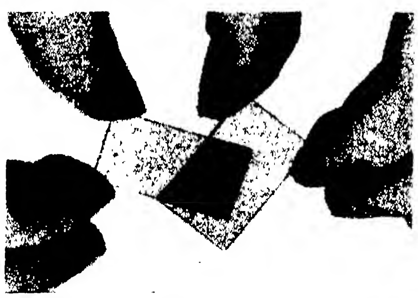
Polarized Light

THERE are several known ways of polarizing light and polarized light is now widely used in the laboratory. However, although there are many known important applications for polarized light in industry, its use has been practically confined to the laboratory because the methods in use have been inconvenient and very expensive.

Alvin M. Marks, research engineer, has developed a means of coating a thin layer of an optically active substance, capable of plane polarizing light, on transparent sheets



Left: **Two plates with their planes of polarization approximately alined.** *Above:* **Same plates rotated so as to obstruct almost all light**

in practically unlimited areas. When one looks through two of these glass sheets arranged to produce light polarized in the same plane, they are quite transparent, but if these are turned through 90 degrees relative to this position, they obstruct almost all of the light and so appear quite black.

The immediate use for this method of obtaining polarized light is in the field of scientific instruments where its use should permit of more extensive research in a most important field of science. However, the widest uses will come in virgin fields. For the motor vehicle, it may serve to cut off the glare of a headlight through the windshield; and thus, incidentally, to permit the use of stronger headlight bulbs, with a resultant greater road illumination. Other large uses are for stereoptic views, variable density goggles, and advertising displays to obtain beautiful color effects of the kind visible with polarized light.

Revolving Auto Service Station

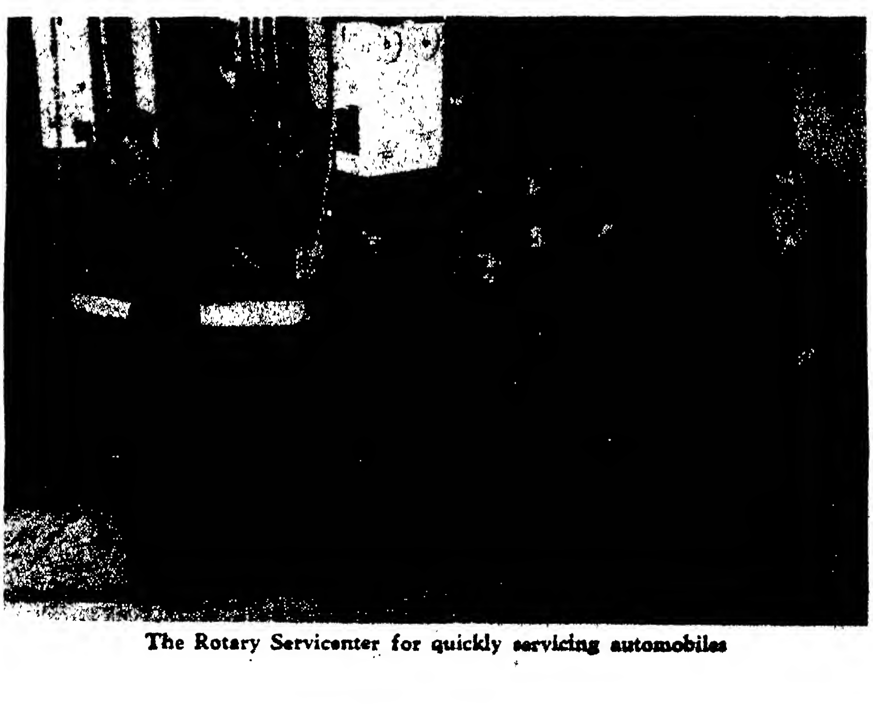
THE first revolving service station in this country was opened recently when the Esso Rotary Servicenter at 93 Lafayette Street, New York, received an automobile on its giant turntable, whirled it around an island of dispensing equipment and in less than two minutes sent it out into the stream of traffic completely serviced with oil, gasoline, air, and water.

Designed by the Colonial Beacon Oil Company, this new unit is a unique development of the service station. Its principal features are that it requires less land than the old type of service station with equivalent facilities; it is economical to operate; it speeds service to the motorist; it necessitates no awkward backing and turning to get to the pumps; and it keeps the motorist indoors while his car is being serviced.

The station itself is a building 41 feet wide by 75 feet long. As the motorist enters this building, he drives on to an electrically operated turntable 37 feet in diameter. This turntable revolves around an island which contains an office, display rooms, and dispensing equipment. As a car drives on, the attendant presses a button and the car is moved to one of three positions convenient to pumps and other dispensing equipment. Three cars can be serviced on the table simultaneously.

Color Photography

A THREE-COLOR amateur movie film that may be used with any camera and projector, has just been announced. Known as the Dufay film, it is being developed also for use in still photography, in which prints will be made on paper. Scant details available at press time reveal the process to involve a screen or mosaic of three-color dots on a single film base. The mosaic is applied to the film by a precise machine which prints in three colors and suitably bleaches



The Rotary Servicenter for quickly servicing automobiles

and dries the criss-cross lines of the color-recording screen.

A full description will be published in our June number.

Chemical Improves Printing Ink

A NEW chemical, colloidal aluminum in linoleate, for use in printing inks, is said to have advantages in commercial printing runs of savings in cost, smoother laying, clearer plates, and less tendency to offset. This chemical is entirely colloidal, without crystalline form, and contains a high percentage of chemically fixed available moisture.—*A. E. B.*

EDUCATION

NEARLY 50 percent of all institutions of higher learning in the United States are located in 10 states. There are 229 colleges for men, 270 for women, 1163 coeducational institutions, and 107 Negro institutions of higher learning.

Our Own Disinfecting Plant

THE upper intestinal tract has a natural disinfecting power that, when we are in normal health, kills off most of the germs that come into the stomach by way of the mouth, Dr. Lloyd Arnold of the University of Illinois told a recent meeting of the Chicago Medical Society. This is the reason why we do not have more diseases of the intestinal tract.

He and his associates have been working for 12 years on determining the bacterial flora of every inch of the digestive tract. The lower intestine is very densely populated with bacteria, he declared, while the upper intestine and the stomach have normally very little bacterial life. The secretions of the stomach and upper intestine are acid in their reaction, while in the lower intestine the reaction is alkaline. There is, however, no "gate" between the upper and lower intestines; it is the line of acidity that determines the height that the bacterial flora will ascend. Consequently, if, for any reason, the acidity of the upper digestive tract is lessened, the bacterial flora of the lower intestine may ascend even as far as the stomach, and the disinfecting power of the mucous lining of the intestine is not able to function properly. *Science Service.*

PROGRESS In This Age Of Science

As Told to Scientific American

By C. F. KETTERING

General Director, Research Division, General Motors Corp.

WHAT the world needs most today are new ideas—new things to make jobs to put men to work. One of these days we are going to discover some new fundamental facts which will keep us industrially busy for years. We have been so busy in the past 50 or 60 years applying to every-day use the fundamental information handed down to us by the great scientists of the last century that we have neglected to continue the work they started. It is time we went back and picked up the job of digging into the mountain of fundamental scientific facts where Faraday, Newton, Thompson, Henry, and many others stopped. Some of the recent discoveries in physics and chemistry indicate that this work is already under way.

In applying these new facts in the future we will have to use more intelligence than we have sometimes done in the past. New things should not be built which will be obsolete before they are paid for. We must plan for change, for change is our only constant. No one can tell what the future will bring, but anyone can fortell that there will be change. If those behind our new era of prosperity will realize this fundamental truth, and build and use only what can be paid for as we go along, our future prosperity will be assured and we will be able to continue to progress unhampered by old debts and mortgages for things which have become obsolete. We must build on a firm foundation of scientific facts, realizing that this means constantly providing for new factors in our every-day life without the tremendous upheavals which we have experienced in the last few years.

Chinese Army Motorizes

THE general belief that the Chinese are extremely backward in military affairs is contradicted by the accompanying photographs of modern aircraft defense equipment, belonging to one of the Provincial Governments of South China. A fleet of Chevrolet trucks has been equipped with high-powered search-lights, and generators to supply current to the lights and to their motor-driven elevating and traversing mechanisms. With each search-light truck goes a trailer bearing an elaborate system of electric sound detectors and direction indicators, by which listeners can learn of the approach of an airplane long before it gets within the range of the lights or, by day, of the anti-aircraft artillery.

Modern American motor trucks equipped for military service and owned by one of the Provincial Governments of South China. The trucks serve as fast transportation units for powerful search-lights and sensitive sound detectors

Tides Influence Beach Erosion

WAVES are the sea's battering-rams, in its endless warfare against the land, but tides are the wheels on which these weapons are borne into position to make their attacks.

This, in summary, is the importance of tides in the erosion of shorelines as discussed by Capt. Paul C. Whitney of the United States Coast and Geodetic Society, before a recent meeting of the American Shore and Beach Preservation Association.

Tides affect the height, or position, of the erosional action, so that their rise and fall as little as a foot in some places, as much as 50 feet in others—is a matter of great importance. Tides also influence long-shore currents, which modify the angle of wave attack, and carry away the sand and rock fragments after they have been dislodged.

The Coast and Geodetic Survey, Capt. Whitney said, maintains a number of pri-

mary tide stations where continuous observations are being secured along the coast of this country, as well as numerous short series stations. These data, in addition to serving the basic purposes of the Survey, are available for interpreting and correlating the tidal information secured by engineers in their studies of erosion effects on shorelines.—*Science Service.*

Quick Setting Acid-Proof Cement

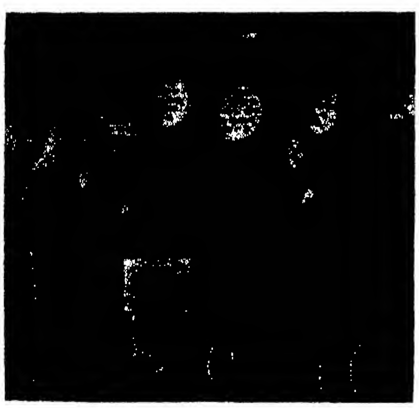
A NEW cement which should be of interest to many lines of manufacture, engineering, maintenance, and construction, will harden by setting within 36 hours. The initial set, which requires only about one hour, is sufficiently rapid to permit a continuous job of bricklaying. The old method of delayed drying is unnecessary.

This new cement is a white powder of high silica content which is mixed with water to a smooth, creamy consistency. It hardens by chemical action into a strong, acid proof and porcelain-like structure of permanent durability.

Heretofore, it has been necessary in plants where there are many acids and their corrosive fumes, or solvents, for the floors to be built of wood as no concrete would withstand these materials. This new cement resists such materials as well as water and fire.

Huge Flashlight Picture Made Indoors

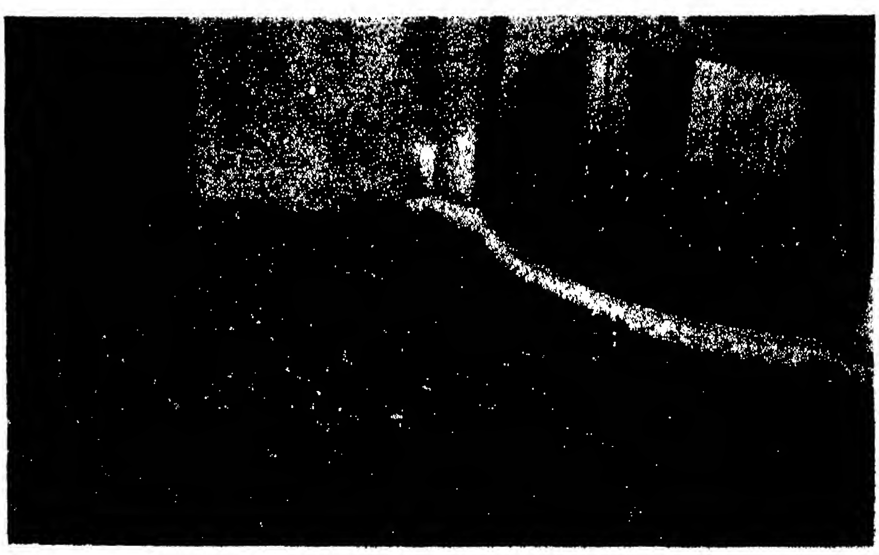
GUESTS of the General Motors Corporation at a recent broadcast in the Center Theater of the National Broadcasting Company, Radio City, were also a party to a flashlight picture made during the program. Three cameras were located in the



Above: **The camera and flashlight equipment used to make the huge "shot" of a broadcasting studio reproduced in photo at the right**

first and second balconies. Two of these in the front row center of the first balcony made a picture of the audience and stage combined. The third camera took an angle view of the audience and stage from the second balcony. Panchromatic plates were used with an instantaneous exposure.

A total of 138 Photoflash lamps, divided among eight reflectors, were used. Six of the reflectors were located equidistantly along the first row of the first balcony to produce an even spread of light throughout the theater. These were equipped with 19 Photoflash lamps each, one flashing by current, the remainder by induction. Two other reflectors with 12 lamps each, one in each wing, were used to build up the illumination on the stage.



NO DANGER?

ALTHOUGH thousands of "shooting stars" penetrate the earth's atmosphere every day, there is no authenticated case on record where a person has been killed or injured by a meteorite or a particle of one. There are actually only about eight cases on record where even property damage has resulted from a meteorite and this damage has not been serious.

Explosions under the Microscope

TWO French physicists, according to *Current Science,* have exploded a milligram or less of lead nitride—a very powerful detonating agent—under microscopes, and studied the metallic markings on the slide. They have discovered that the air wave from one particle explodes another particle before the hot gases actually reach it. Metallic lead patterns on the slides after each tiny blast show the directions of the forces liberated.—*A. E. B.*

Thermit Welding Saves Huge Casting

ONE of the largest Thermit repairs in many years was completed recently at a mid-western steel mill. The broken part was a housing of a 160-inch plate mill. The casting, minus all appurtenances, weighed 164,000 pounds, stood 21 feet 8½ inches high, and was 14 feet 9 inches wide at the base and 10 feet wide at the top.

The original fracture, which caused the housing to be removed from service, occurred in the lower portion and ran from an inside corner diagonally downward through a tee-shaped section, one leg of which was 38 inches by 12 inches and the other leg 30 inches by 26 inches. In preparing this fracture for welding, another crack was discovered above the first, running through a section shaped roughly like

Four tons of Thermit were used in welding cracks in this huge casting

an I-beam with members 26 inches by 8 inches, 26½ inches by 8 inches, and 30 inches by 15 inches.

Four tons of Thermit—superheated Thermit steel, a mixture of finely divided aluminum and iron oxide ignited in a crucible—were required to make the two welds. The entire job, from the waxing of the first fracture to the pouring of the second weld, was completed in exactly one week. The cost of the two welds was only a fraction of the cost of a new housing.

Fortification with Vitamin D

THERE is no convincing evidence from the standpoint of public health of a need for the fortification of foods with vitamin D other than such staple products as milk, cereals, and bread, which form the basis of the customary diet of the public throughout the year. It is nutritionally unreasonable to add vitamin D to foods consumed mostly in the summer when sunshine is sufficient for producing this vitamin in the body, or to foods consumed irregularly,

(Please turn to page 267)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

A TELESCOPE having some new features has been completed by Nathaniel B. Archer, of 310 Pine Street, Green Bay, Wisconsin, whose letterhead indicates that he is a research, experimental, and design worker in machinery, and related problems in electricity, chemistry and physics; a maker of mechanical motions and laboratory apparatus, also of astronomical instruments and fine and small shop work. The optical parts of this telescope, which has an 8-inch mirror, except the polar axis finder, "were made," according to Mr. Archer, "by Mr. C. T. Elias of Appleton, Wisconsin. The main tube was made, chiefly, at the Green Bay Vocational School under the direction of their Mr. Thorpe.

Figure 1: **The Archer scope**

"The photograph, Figure 1, shows the mobile mounting truck. The retractile (swinging) stabilisers are used for alining the polar finder upon Polaris, as explained later. The steering tongue is detachable. The brace rods were found materially to reduce the oscillation of the mounting, which is inherent in the slender pedestal shown.

"The worm gearing of the hand drive is made with a V-form thread, the wheel having been hobbed with a ⅝", 11-thread USS tap. The V-form gear tooth is satisfactory for this service, if an arrangement be provided for accurately adjusting the backlash or looseness of the worm and wheel.

"The equatorial mounting was made, partly, from parts supplied by Mr. Elias. It is provided with babbitted bearings, which are found to be superior, in point of performance, to the ball bearings installed in an instrument built previously by others. Ball bearings have so little inherent friction that the instrument will not retain a given setting unless the brakes are set with some force.

"The circle wheels were made from gear wheel castings. The outer rim (in which teeth are cut) was turned down and that surface given a ⅛-inch coating of hard (bronze) solder. This was again turned down until a smooth surface was produced. The circumference was divided in an engine lathe, using the lathe's gearing as an available indexing or dividing device.

"The polar axis finder, a new feature (Figures 2 and 3) designed by the writer, is arranged to compensate, semi-automatically, the angular distance of 1°07" between the celestial pole and Polaris. The constellation Ursa Major is represented upon a disk, which is revolved until the position of its markings corresponds to the apparent position of the constellation itself in the sky at the time. If the main mounting of the telescope proper is then adjusted until Polaris is seen at the juncture of the cross hairs in the polar-axis finder, the polar axis of the mounting will be found to be almost precisely parallel with the axis of the earth. The finder is mounted in gymbals (Figure 2) at its upper end, and the eyepiece draw tube is passed through an eccentric hole in a disk, which is rotatably mounted upon the frame of the equatorial mounting. This disk is engraved with a representation of the constellation Ursa Major and Polaris.

"First, the mounting is roughly set into alinement with the celestial pole, and the triangularly placed handscrews on the base are turned down against the ground. By varying the relative adjustment of these hand screws, Polaris is brought to the in-

Figure 2

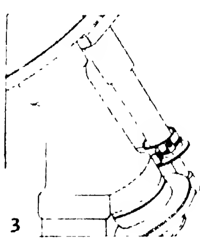


Figure 3

tersection of the cross-hairs in the finder. As shown in Figure 4, if Polaris is seen at the intersection, then the polar axis of the instrument will be almost precisely alined upon the celestial pole. I made this finder from the lenses of an old Kodak, and it was found to be quite satisfactory for its purpose."

WALLY EVEREST, that famous landmark of Pittsfield, Mass. (15 Allengate Ave.), after being teased and teased (he is so shy) has kindly furnished us several pictures of "The Old Town Pump," also a noted landmark in that quaint New England hamlet. How did it come to be called Ye Olde Town Pump? Well, somebody thought the polar axis looked like a pump handle and, after that, that was that. Ye Olde Towne Pumpe has a Pyrex mirror, and look (turn the page) at those Ronchi bands! Everest had made 149 optical surfaces before he turned this one off, and this was his 150th. What we like about it shows best in Wally's "longitudinal cross-section" (as some genius recently described it): its *rigidity*. Study the details of that tapered polar axis. Then take a squint at the diameter of the declination axis. Then note the unusual setting circles—the indexing does not show, in the photograph, on either circle, as the light evidently caught them wrong. The declination circle is the light-colored streak, in line with the polar axis. Note also the worms and the rollers. A fine design. We also received some other photographs of Everest as an artist's model but this is not an arty magazine, hence they had to be suppressed even if Anthony Comstock is no longer an obstacle. Too bad—they were beauties.

AND now we learn that Mary A. (Mrs. A. W.) Everest, same address, has made the first feminine aplanat on earth, so everybody give three cheers and three times three! And here, in the photograph, is Miss Sylvia Petersen, 963 Tenth Ave., St. Petersburg, Fla., with a Newtonian telescope she made. The moon in the background, likewise the stars, are not the real ones. Miss Petersen was chosen "Miss America" in a recent beauty pageant.

SEVERAL have worked out ways—some rather complicated and mathematical, some less so—for making the Ronchi test quantitative as well as qualitative, and the first to be published was that of J. H. King, in the *Journal of the Optical Society of America*, Sept., 1934. We have been asked who was the first to work out a method, and the answer is, we do not know. Several evidently were at work on this problem at about the same period—Loren L. Shumaker of Dayton being one. Alan R. Kirkham of Tacoma, for example, sent us an outline of his method in March, 1934, and he has now, at our request, sent us the following succinct statement which is a paraphrase of the one he sent us then, and which we unjustly mislaid and overlooked at the time.

"The Ronchi test may be used to measure

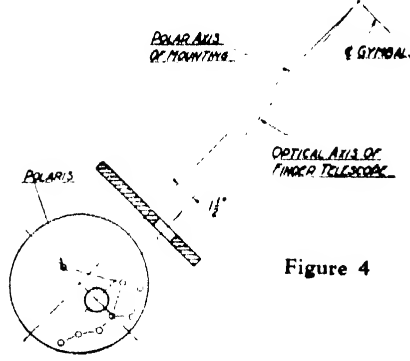


Figure 4

the overall correction of a mirror very simply, in the following manner: Adjust the grating so that two bands at the center of the disk are 1 inch apart (say) and mark the position. Now move the grating back so that the bands are 1 inch apart at the rim. The move should amount to r^2/R, if the correction is right." This statement should be substituted for the one on page 267 of "Amateur Telescope Making," where

Miss America, of Florida

it states that "the Ronchi test is not quantitative," and in the next corrected reprinting of the same book it will be so substituted.

THE following is our present list of clubs of amateur telescope makers. Prior to its publication elsewhere, we wish to obtain all corrections for this list, also similar data regarding telescope makers' clubs not now listed in it. We wish also to compile a separate list of purely astronomical clubs.

Telescope Makers of Springfield, A. D. Baker, President, Springfield, Vt.

Astronomical Society of the Stanley Club, A. W. Everest, President, 15 Allengate Ave., Pittsfield, Mass.

Tri-City Astronomical Club, Bernhard Nordblom, Jr., Secretary, 929 Grand Ave., Davenport, Ia.

Amateur Telescope Makers of San Francisco, Dr. Frances P. Epley, Flood Bldg., San Francisco, Calif.

Amateur Telescope Makers of Berkeley, Dr. W. T. Bush, American Trust Bldg., Berkeley, Calif.

Amateur Telescope Makers of the Golden Gate, a federation of the San Francisco and Berkeley clubs named above, with Oakland and other Bay cities clubs, addresses of the latter unknown.

Academy of Science and Art of Pittsburgh, Astronomical Section, Leo J. Scanlon, Pres., 1405 East St., Pittsburgh, Pa.

Infamous Poses of Famous Amateurs, Series A, No. 1. Alan R. Kirkham of Tacoma, in hiding

Amateur Astronomer's Association, Telescope Makers' Section, Ramiro Quesada, leader, American Museum of Natural History, New York, N. Y.

Amateur Telescope Makers of New York, Lew Lojas, 1510 White Plains Road, The Bronx, New York, N. Y.

Amateur Telescope Makers of Chicago, William Callum, Sec., 1319 West 78 Street, Chicago, Ill.

Amateur Telescope Makers of Cincinnati, W. Clemmer Mitchell, Sec., 2390 Wheeler Street, Cincinnati, Ohio.

Amateur Telescope Makers of Indianapolis, V. E. Maier, Sec., 1306 Parker Ave., Indianapolis, Ind.

Amateur Astronomical Society of Los Angeles, E. A. Letscher, 1016 S. Normandie Ave., Los Angeles, Calif.

Amateur Telescope Makers and Astronomers of Tacoma, George Croston, Sec., LaGrande, Wash.

Eastbay Astronomical Association, Telescope Makers' Section, Franklin B. Wright, Chairman, 155 Bret Harte Road, Berkeley, Calif.

Everest's polar axis—no shimmy

Amateur Telescope Makers of Buffalo, Thaddeus Czerniejewski, Chairman, 113 Franklin St., Lackawanna, N. Y.

Amateur Telescope Makers of Dayton, William Braun, Sec., 115 Bolton Ave., Dayton, Ohio.

Detroit Amateur Astronomical Society, Howard Morehouse, 4336 Dickerson Ave., Detroit, Mich.

Amateur Telescope Makers of Boston, Wagn. H. Hargbol, Pres., 600 Beech St., Roslindale, Mass.

Amateur Telescope Makers of Kansas City, Edward F. Bowman, Pres., 1406 Ewing Ave., Kansas City, Mo.

Westinghouse Astronomy Club, Fred C. Wilharm, Box 63 Homestead Station, Pittsburgh, Pa.

Astronomers' Guild of Jamestown, J. Elwood Johnson, Pres., 28 S. Main St., Jamestown, N. Y.

Amateur Astronomical Association, Joseph A. McCarroll, Pres., 521 Palisade Ave., Teaneck, N. J.

Louisville Astronomical Society, O. W. McCarty, Pres., street address unknown, Louisville, Ky.

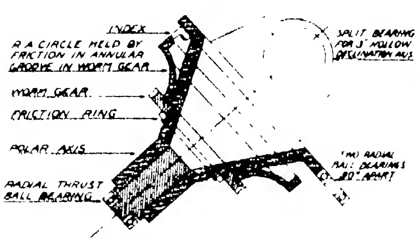
WE are running to rather lighter stuff this month, as relief from heavier stuff, past and future. Here are two items from men who believe the world is flat. Whoever supposes that such people do not exist in this century should sit for a few days at the receiving end of an editor's mail.

Arthur C. Bates, 322 B St., Marysville, Calif., who asserts that he is the only authority on the flat earth theory, claims that the earth is a huge island and says that the sphere theorists (that's the rest of us—or so we suppose) claim that the earth is round. But, he says, they cannot account for the fact that, if this is so, the River Nile must run uphill for over 30 degrees. Mr. Bates challenges all believers in the sphere theory of astronomy to prove their theory, and disprove his claims that "the earth is a huge island, flat, so-called."

The Old Town Pump

Unlike Mr. Bates, who claims to be the only authority on the flat earth theory, Mr. H. M. Tozer, 8 Victoria Road, London, S. E. 19, England, says he is only a keen student of the same theory. He wonders, he says, how people can go on asserting that the earth is a ball, when there is so much evidence against it, and then proceeds to cite various evidences.

Come now, all ye who dare risk being proselyted to a flat earth theory, and write to Messrs. Bates and Tozer. But please, kindly, leave us out of it; we have our regular job to attend to, and to keep out of an argument we would almost agree that the earth is a huge island, flat!



Longitudinal section of pun.p

IN the February, 1934, number we published a discussion of photo-electric telescope guiding, by L. Jackson Bulliet, and followed this up in July and August, 1934, with contributions by Messrs. Silvertooth and Barkelew, respectively. Mr. Bulliet has been working on the problem, in the meantime, and while he does not claim to have solved it—a formidable task, we fear—he does send in an interesting progress report.

"Upon my return to Indiana University in the fall of '34," he writes, "I adopted this matter as the problem for my master's thesis, and immediately banged into the trouble predicted by Mr. Kirkham—star light is so exceedingly feeble that only the most sensitive photo-cell can be considered for use, and this must be supplemented by remarkably powerful current amplifiers. I soon saw that our research budget would not permit buying four cells and four amplifiers. However, I saw I could cut it down to one of each by confining the operation to drift in right ascension. This is permissible in stellar photography, since the north-south drift may be entirely cut out by careful orientation of the polar axis. Of course this precludes using the machine on comets and planets which drift appreciably in declination.

"Having decided to stick to right ascension (or clock inaccuracy) guiding, I saw that the drive clock could be deliberately set ahead or behind sufficiently to mask the irregularities of going, and thus always give a net drift in the same direction. Hence we can use one cell and have it energized whenever the star image drifts off a knife-edge in the focal plane—it won't drift the other way.

"Well, I built such a machine, using a special cell made by Dr. Kunz of Illinois University and General Electric's FP-54 amplifier tube—33 dollars each for these two pieces. It seems to be sensitive enough to respond to the very brightest stars, but there is always a little erratic current of about the same order of magnitude as the cell current. So the arrangement is not yet ready to use for photography. I am still hopeful of increasing the sensitivity, but find my time limited by my duties as assistant in the department. I have delayed writing, in hope that I might have definite positive results to report, but decided to let you know that I am still plugging away at what I still think is an important problem."

Sweetest Ronchi bands we've seen

HERE is a hot one! It seems that R. W. Porter and Byron L. Graves (A. T. M., 136,358) were standing on a street corner in Los Angeles talking about telescope making and mirrors in general, and Graves was frequently using the expression "surface of revolution." The next thing that happened was a sudden descent on these two bewildered optical enthusiasts by a police radio car with a small riot squad. It appears that some woman, passing by while they talked, had breathlessly notified the police that "two desperate looking characters were plotting a *revolution*,—she had heard them—right on the streets of Los Angeles!" O, California! O, Los Angeles!

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 262)

especially in the fall, winter, and spring months. An important prerequisite in the choice of food for incorporating vitamin D is that it be consumed regularly and in considerable quantity in the usual diet throughout the year.

Examples of foods not warranting fortification with vitamin D are sausage and ice cream and such accessories as chewing gum.—*From a general decision and report of the Committee on Foods, American Medical Association.*

Ultra-Violet Treatment of Milk

ULTRA-violet light is known to increase the vitamin-D potency in milk. Experiments have been made in this direction by giving dairy cows regular treatments of ultra-violet. Instead of irradiating the cow, however, the latest procedure is to irradiate

Set-up for treating milk with ultra-violet, showing the water cylinder

the milk, the process being accomplished very rapidly by passing the light through a thin film of milk as it flows through the device shown above.

The irradiator consists of a carbon arc, the carbons having a motor-controlled feed. Around the carbon arc is a cylindrical film of flowing water, about .008 of an inch thick. This film of water is gas-tight and serves as a chimney for the fumes of the flaming arc. Surrounding this water-film chimney, the milk film, also .008 of an inch thick, issues from a slot. The milk is thus exposed to the ultra-violet light for but a fraction of a second, as it flows swiftly by. Capacity is controlled by a positive feed pump, and for standard vitamin-D potency is 4000 pounds of milk per hour.—*A. E. B.*

Washable Elastic Webbing

YOU may expect to find your pet windbreaker or bathing suit or golf slacks styled with elastic webbing this spring for

extra comfort and perfect fit. "Stretch-Tex," a new and improved type of woven elastic webbing which can be dry-cleaned safely and can "take it" in the laundry has been developed by the American Mills Company. The web is made with cut rubber thread and processed to insure resistance to perspiration, salt water, and sun. It has been subjected, according to Norman A. Cook, to exhaustive tests for strength, ageing, resiliency, dry-cleaning and laundering by the Pittsburgh Testing Laboratories and American Laundry Institute. Considering the ingenuity of stylists and designers we will now probably find elastic webbing where we least expect to find it.

FIFTH PLACE

PAYING its way in a hurry, aluminum has attained in 44 years fifth position among metals in point of use and volume produced. The first four—iron, copper, lead, and zinc—have been developing for centuries.

15-Pound Aircraft Radio Transmitter

A NEW long distance radio telegraph transmitter weighing only 15 pounds and delivering a nominal 75 watts of continuous-wave radio-frequency power to the antenna, has been developed by Westinghouse. The new CH transmitter operates on frequencies ranging from 333 kilocycles up to 10,000 kilocycles by means of plug-in coil assemblies. This provides for operation with marine stations, including ships at sea, as well as operation on the aviation communication bands.

The set operates from the 12-volt battery system of the plane through a dynamotor. The plate supply voltage of 500 utilized for a transmitter of this power, as compared

Light-weight airplane radio set

with 1000 volts usually employed, is a decided advantage for reliable operation under various climatic conditions.

The dynamotor is purposely designed for aircraft service. It is unusually light in weight although ruggedness has not been sacrificed. The use of magnesium alloy castings combined with careful design has resulted in a machine of 13½ pounds weight capable of delivering 150 watts of 500-volt power to the transmitter.

The equipment is of splash-proof construction. Provision for ventilation and cooling of the transmitter is by means of louvres in the sides, small openings in the bottom, and suitable drip-proof ventilators

at the top. The dynamotor unit is totally enclosed.

The shockproof unit for the transmitter consists of four molded rubber cylinders contained in removable aluminum cans, these units being attached to the under side of the transmitter sub-base plate. The shockproof unit is designed to screw or bolt securely to the mounting board in the plane. A plug-in power connector block is utilized to bring all input power and control circuits to the transmitter.

To Renew Typewriter Ribbons

Any business man whose office force uses a large number of typewriters well knows the appreciable expense made necessary by the constant purchase of new typewriter ribbons. In the past, numbers of devices have been developed using various kinds of solutions to renew the brightness of color in old ribbons and thus prolong their life.

Renewing typewriter ribbons

A new one which has just come to our attention, and which, according to the records, has proved successful in extensive use already, was developed by the Ribbonew Corporation of America.

This new device consists of a small solvent container molded of Bakelite, through a side slot of which the typewriter ribbon may be passed while on the machine. It is only necessary to hold the device in position and wind the ribbon through from one end to the other once a week. It is claimed that such an application of the solvent will keep the ribbon in a soft and pliable condition, always ready to turn out sharp, bright, full color work.

300 Years of Chemistry

Three centuries of chemical industry in America, dating from the early beginnings by John Winthrop, Jr., first governor of Connecticut, will be celebrated by the American Chemical Society at its 89th meeting in New York, April 22-26, 1935. The essential place occupied by chemical manufacture in the lives of the earliest white settlers on this continent, as well as in modern civilization, will be particularly emphasized. Chemical manufacture in the United States today produces in value more than 21 percent of that of all manufactures, and contributes to every activity of the people.

At this meeting, which is expected to be the largest gathering of chemists ever held in the world, will be presented more than 500 scientific and technical papers dealing with the latest advances in chemical science and industry. Co-operating in arranging for

this huge gathering are both scientific and industrial organizations in the field of chemistry. Many of the events connected with the program will be broadcast for the benefit of radio listeners.

Among the speakers will be such leaders of industry as Lammot du Pont, president of E. I. du Pont de Nemours & Company; William B. Bell, president of American Cyanamid Company; Thomas Midgley, vice president of the Ethyl Gasoline Company; such leaders of science as H. C. Urey and Irving Langmuir, Nobel prizemen in chemistry; and such leaders in public life as Senator Pat Harrison of Mississippi; Honorable James Wadsworth, Jr., Congressman from New York; and Francis P. Garvan.

NUMBER!

"Day Huey Bin She Ah," is what telephone operators say in China. It corresponds to our "Number, Please." Many people would like to "get the number" of our own Huey!

Pumping by Electricity from Bottom of Well

"IF we can't pull the oil out of deep wells, then let's push it out."

That, in few words, is the answer of Dr. Edward C. Ekstromer, of Los Gatos, California, electrical engineer, to petroleum engineers who seek to recover countless millions of barrels of oil deposited so far beneath the earth that present-day equipment cannot pump it economically to the surface. Producers have added length after length to their "sucker rods" until in many instances they were more than a mile long.

At that length, the rods represent a tremendous dead weight for the power plant to lift up and down at each stroke. Furthermore, the stretch in the rods wastes approximately half the stroke. The rods crystallize under the constant movement and in most deep wells have to be replaced at great cost and loss of time every few months.

Dr. Ekstromer set about to find a substitute for the "sucker rod" system. He solved the problem of putting the power at the bottom of the well by an ingenious arrangement of a series of small diameter, alternating current motors operating in unison, each delivering its quota of power. The number of units employed depends upon the depth of the well, which governs the power requirements. The motors and mechanical parts were enclosed in an oil- and water-proof cylindrical seamless-steel housing, approximately 35 feet in length with adequate lubrication for bearings for long periods.

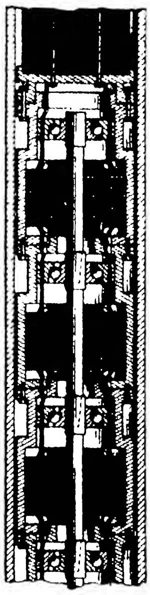
Within the assembly above the motor units is an epicyclic reduction gear mechanism for transmitting power from the motors to the driven worm-shaft at a lower speed. The complete unit will withstand and operate in high temperatures, a condition often prevailing at the bottom of deep wells. An ingenious ejector device expels unwanted liquid—water and oil—which, because of hydrostatic pressure, would otherwise leak through the packing gland into the chamber.

But even after a power unit had been pro-

duced which was sufficiently slender to be dropped to the bottom of the well, the whole problem was far from solved; the power thus created was centrifugal and no centrifugal pump has yet been devised to raise oil 5000 to 10,000 feet.

This seemingly impossible task was accomplished by converting the centrifugal power into reciprocal movement.

The motion changing device evolved consisted of a shuttle mechanism adapted to move with a reciprocating movement along a double threaded helix worm-shaft, as the latter is driven continuously in one direction. At each end of the worm-shaft, the movement of direction is automatically changed, with no perceptible interruption in torque being indicated on the electrical instruments placed in circuit. Thus, Dr. Ekstromer was able to deliver, at the bottom of the well, a reciprocating prime mover capable of furnishing a fixed stroke of the desired length to meet the requirements.



***Right:* Compact motor unit assembly for use in pumping from the bottom of deep oil wells**

The submersible power unit makes possible recovery of billions of barrels of oil that cannot be lifted economically to the surface by standard rig equipment. The farther down the drillers go, the better the oil is, and the more there is of it. Oil experts say that within five years the shallow wells in this country will be a thing of the past. Then we will have to rely on the deep pools for our petroleum supply.

NON-EXPLOSIVE EXPLOSIVE

As explained in the article on Nitramon in our April issue, safety combined with high efficiency has been achieved in the development of this new blasting agent. According to informed opinion, it represents the most revolutionary advance of its kind since the invention of dynamite by Nobel.

Heating Nitramon with a blow torch to demonstrate safety of explosive

A rifle bullet tore through the Nitramon but did not detonate it

Oddly enough, Nitramon is not an explosive in the accepted sense of that term, even though it is capable of performing the same tasks as do high explosives. In fact, it has been conclusively proved that this particular blasting substance can be set off only by so powerful a primer as 40 percent, or stronger, dynamite; and at that it requires a dynamite cartridge of at least four-inch diameter and eight-inch length to detonate a cylinder of Nitramon four inches in diameter. In other words there is need not alone for intensity of shock, but also for volume. Of course, where a number of cans of Nitramon are loaded in a continuous column in a quarry bore hole, only one dynamite charge is necessary since the "explosion wave" will propagate detonation of all cans successively.

At the time we obtained material for our brief note last month, pictures were not available. Since then we have obtained photographs showing the non-explosive effect of a high-powered rifle bullet when shot through the can, and of "cooking" Nitramon with a blow torch. These are shown on this page as effective proof of the claims that no amount of rough handling can cause an accidental explosion of Nitramon and thereby endanger lives or property.

Already Nitramon has proved its value for such important work as quarrying, stripping rock from coal deposits and for some other industrial blasting operations in the open. It is not, however, intended for use in mines other than open pit.

HUNGER GETS LESS

Hunger is often more pronounced just before a regular meal than after a fast of 24 hours or more, Dr. Robert N. Sanford found in research at the Harvard University psychological laboratories.

Observing the reactions of the human mind under various degrees of hunger, he found that the "food habit," food appetite, and biological requirements of the body in many cases were more important factors

than the passage of time in determining a subject's attitude toward food.

According to the results of his experiments on more than 300 students from Harvard, Radcliffe, and Simmons, the passage of a long period of time tends to decrease rather than increase hunger, with most acute hunger present just before a regular meal. Two hours after the meal, hunger decreases about 50 percent, he found, and even from eight to 24 hours after eating, food interest is still less than just before a scheduled repast.—*Science Service.*

Du Pont Profits More in Peace than War

Replying to insinuations of magazine articles, newspaper comment, and Senatorial investigations, that the munition makers foment war for their own private gain, President Lammot du Pont of E. I. du Pont de Nemours and Company, leading smokeless powder manufacturer in the World War, has issued a statement pointing out the fallacy of such contentions. He states that "the du Pont Company does not want war and has vastly more to gain from peace. Not only the strong natural sympathies of its management, but also the plain business interests of the company lie overwhelmingly in the direction of the continued maintenance of world peace."

In support of this declaration, the company's remarkable expansion of its activities in recent years to include practically the whole range of chemical manufactures is pointed out. "In contrast to its original position as distinctly a gunpowder producer," states President du Pont, "the du Pont Company today is essentially and chiefly a manufacturer of products having no relation to war." "Duco," "Cellophane," "Pyralin," "Fabrikoid," rubberized fabrics, pigments and heavy chemicals, rayon, dyestuffs, and many other lines are cited among the examples.

In the company's annual report for 1933, its stockholders were informed that "its Smokeless Powder Department, in which are included sporting powder as well as the military propellants which constitute the great bulk of all military explosives, ranks now tenth and last among the ten manufacturing departments and subsidiaries which make up the company's business, both in amount of capital invested and in volume of sales." It is added in this statement that the "total profits earned by the du Pont company on military explosives of all sorts over the past ten years have amounted to only about 2 percent of the company's total manufacturing profits." Thus, the peacetime products of the company now outweigh its total military explosives business in the proportion of about 50 to one. —*A. E. B.*

FOREIGNER?

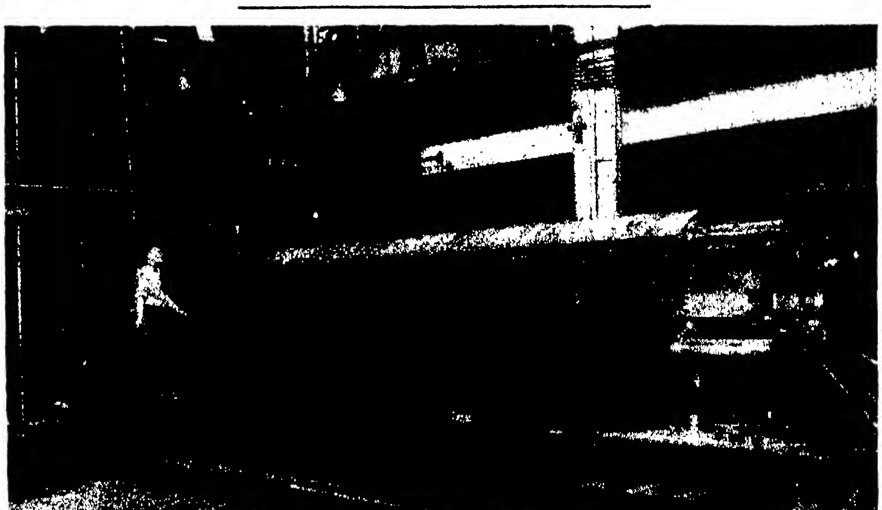
The so-called French type of telephone was invented by Robert G. Brown of New York City and patented by him in 1880. France happened to adopt it before we did; hence the anomaly.

Germs Drift in Air for 48 Hours

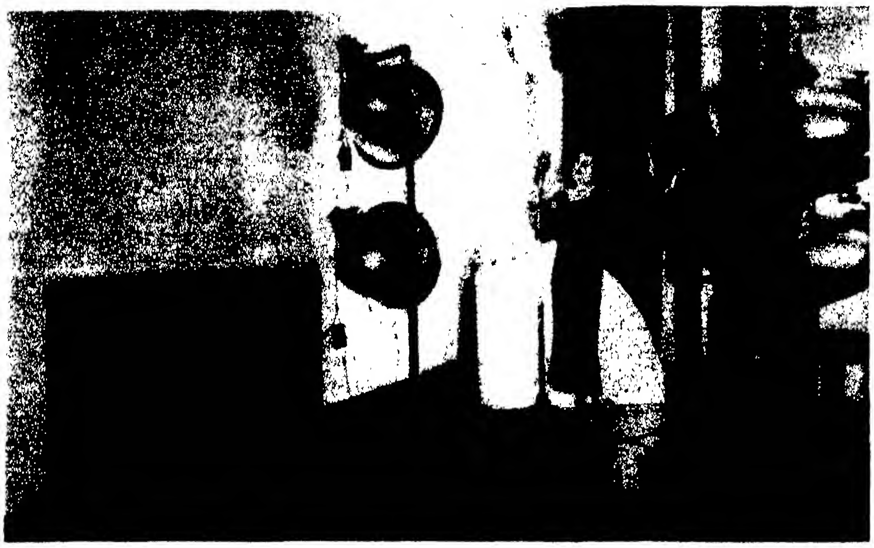
A scientific discovery which holds promise of revolutionizing accepted theories on the possibility of certain respiratory infections being air-borne, has been made by William F. Wells, instructor in sanitation at the Harvard University School of Public Health. The discovery lies in positive evidence that minute droplets expelled in coughing, sneezing, or even in talking, do not fall immediately to the floor, but evaporate and may leave behind infective germs which drift about alive in the air for many hours.

According to previous theories, these droplets fell immediately, due to gravity, within a few feet of their source. Accordingly, the range of possible infection was assumed to be very small, it being believed that the germs must be inhaled directly as they fell for transmission.

Mr. Wells points out that the most significant feature of his work is the distinction between large and small droplets. The larger do, of course, fall to the ground, as has been known for the past 40 years, but the smaller ones, more minute than finely



This huge rotor, shown in the Westinghouse shop, will be part of the world's most powerful single shaft generator—rated at 183,333 kv-a, 13,800 volts, 3 phase, 60 cycles—to be driven by a 1800-rpm turbine. The 26-foot, 250,000-pound rotor is made up of 60-inch disks and end forgings held together by bolts, the 13-inch center bolt, of a strong alloy of nickel-molybdenum-steel, weighing six tons



Air-conditioning may be one reason why the N.B.C. photographer obtains such good pictures of radio stars. Despite the heat from the battery of lamps used to obtain satisfactory lighting, the Westinghouse unit (left) in one of the studios in Radio City, New York, keeps the air cool and the posing artists comfortable

granulated particles of sugar or sand, never reach the floor at all.

Evaporating almost instantaneously, they leave behind tiny "nuclei," so small they are easily carried about by the lightest air currents. Some types of germs, it was found, remained alive for several days, while others died in less than an hour. The infective danger from the spread of germs in this manner is, of course, limited by their respective rates of survival or viability.

Experiments on the longevity of various kinds of germs showed wide differences. Of special hygienic significance, says Mr. Wells, is the difference in viability between respiratory and intestinal bacteria. While none of the intestinal organisms was found alive after eight hours, four respiratory organisms were recovered alive after 48 hours' suspension in air, including the deadly carrier of pneumonia and the source of diphtheria and scarlet fever.—*Science Service.*

OIL

CONSUMPTION of petroleum in the United States is twice that of water. Each day enough oil is pumped from the ground to cover Manhattan Island—12 miles long and averaging a mile wide—to a depth of a foot and one half.

Hybrid Poplars

IN a report recently published by A. B. Stout of the New York Botanical Garden, and E. J. Schreiner of the Oxford Paper Company, the following statement was made relative to the hybrid poplars discussed in our March issue:

"The work of breeding poplars reported . . . was conducted under the auspices and with the financial support of The Oxford Paper Company and with the co-operation of the New York Botanical Garden. The project was initiated by The Oxford Paper Company in the spring of 1924 chiefly through the interest of Professor Ralph H. McKee who was then in the employ of the company as the Director of Research. Professor McKee gave his hearty support to the plans and methods of work developed by the authors."

It is with pleasure that we give this additional credit for the work that has been done in hybridizing poplars. Incidentally, in response to numerous requests that have come to us for the names of commercial nurseries from which these poplars might be obtained, Dr. McKee explains that while the research was completely successful, sufficient stocks of the hybrids are not yet available for commercial distribution.

New Beryllium-Nickel Alloy

A NEW beryllium-nickel alloy, recently announced, can be heat-treated to produce a Brinnell hardness of 460. It is said to be capable of holding a sharp cutting edge. The material is resistant to intergranular corrosion in contact with mineral acids. Fully hardened, the alloy has a tensile strength of 260,000 pounds per square inch, and an elongation of 8 percent.—*A. E. B.*

Learn to Know the Edible Mushrooms

NEWSPAPER accounts of poisoning following the consumption of certain kinds of wild mushrooms have called forth a warning from Professor F. C. Stewart, botanist at the State Experiment Station at Geneva, New York, and a widely recognized authority on mushrooms, that one should distinguish between edible and poisonous mushrooms as clearly as one does between peas and beans or other plants. This is not difficult to do, for most of the mushrooms found in the woods, pastures, and lawns of New York state are quite edible and might well form a welcome addition to the menu, declares this authority.

Prof. Stewart has prepared a brief circular entitled "How to Know the Mushrooms and Toadstools" in which he makes an effort to acquaint the reader with the

commoner forms of wild mushrooms found in New York, and especially to set forth the chief features by which the poisonous kinds can be readily identified in the field. A copy of Prof. Stewart's circular may be obtained upon request to the Experiment Station.

"The only safe way to utilize wild mushrooms is to learn to recognize the edible and poisonous kinds at sight, just as one recognizes peas and beans and poison ivy," says Prof. Stewart. "One must learn to recognize at sight each kind of fungus which he eats and never eat anything which he does not know." He also condemns the various edibility tests and "signs" indulged in by some so-called "authorities" on mushrooms as being wholly unreliable and likely to result in serious difficulties.

Preliminary Shelter-Belt Plantings

ONE hundred and fifty miles of shelter belt planting in the drought area, the *Forestry News Digest* announces, will be made by the United States Forest Service in the near future.

There will be 30 planting areas each about five miles long. These will be divided between six states—North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas.

Approximately four million trees will be required, one hundred thirty-nine thousand for each planting. These trees will be obtained from nurseries in the drought region.

It is estimated that 140 man days' work will be required for each mile, or a total of 21,000 man days for the entire 150 miles of planting.

The work will include nursery production, ground cultivation, fence construction, and so on.

There are now, in sections of the drought area, a great many windbreaks, some of them 50 years old, says Charles Lathrop Pack, president of the American Tree Association. These have demonstrated their usefulness for many years, and in many instances farmer owners of these windbreaks have gathered good crops on the lee side of them despite prevailing dry conditions.

It is roughly estimated that of the trees planted in the drought areas of the middle west including windbreak, shade tree, and general planting, about 50 percent have survived. It is believed that greater care in selection of species for such plantings will increase, considerably, the number of trees that will thrive and live. The Forest Service experts have secured the best information possible to enable them to determine the best trees to plant under different soil, wind, and rainfall conditions.

In sections of the middle west, swamps which have been drained in years past in order to increase farm areas are now being restored to natural conditions by construction of dams. After these swamps are again filled they will aid in increasing humidity and also be of further value in restoring feeding grounds for migratory birds.

Plans for the shelter belt planting are being completed rapidly, and it is expected to start as soon as the weather makes it possible.

Various species of trees and shrubs to be used in the shelter belt plantings will be approximately as follows:

On the outside rows will be planted caragana, choke cherry, haw (buckthorn), buffalo berry, sumac, willows, lilacs.

The rows next to the outside rows will consist of Russian olive, plum, willows, Russian mulberry, osage orange, and apricot (pistacia).

The rows half way between the outside rows and the center row will comprise willows, red cedar, Austrian pine, Chinese arbor vitae, and Arizona cypress.

The rows next to the center rows will comprise green ash, American elm, Chinese elm, burr (post oak), hackberry, willows, honey locust, black Texan walnut, black locust, chinaberry, and pecan.

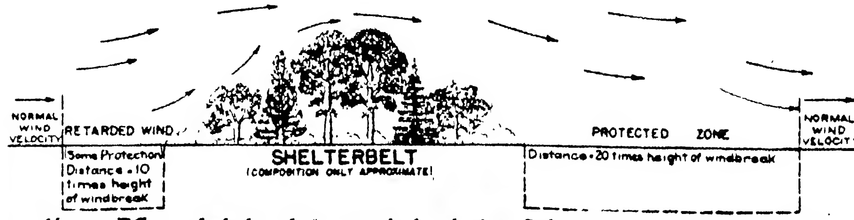
The center rows will be composed of cottonwood, willows, and black locust.

A Modern Jo-Jo

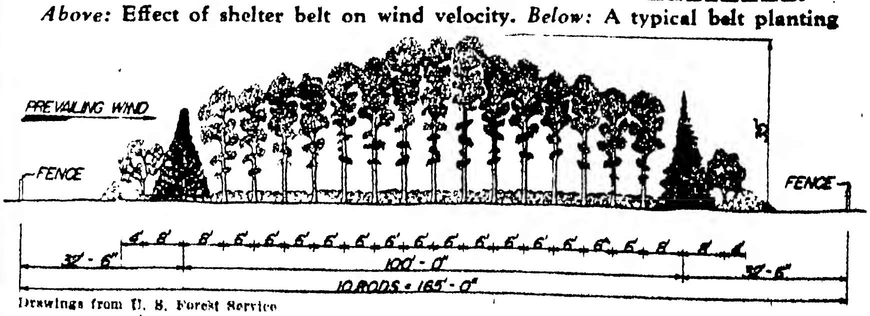
A SO-CALLED "dog-boy," like the famous Jo-Jo exhibited by Barnum many years ago, is living in the city of Kharkov, U.S.S.R.

The child is entirely covered, face and body, with long blond hair having somewhat the texture of goat hair, coarse and a little wavy. He is being studied in the children's hospital and clinic in Kharkov.

The child is now four years old and, according to the last report, is in good health except for a case of rickets for which he is being treated. He is normal mentally as well as physically. Both parents and the boy's older sister are normal in



Above: **Effect of shelter belt on wind velocity.** *Below:* **A typical belt planting**



Drawings from U. S. Forest Service

every respect and no similar condition has occurred in any member of the family on either side, so far as the parents know.

The condition is known to scientists as hypertrichosis universalis. It is a congenital defect like harelip and is thought to be due to an arrested development of certain structures of the body. The first hair coat, which covers the body of a child before birth and is usually shed soon after birth, persists in cases like this of the Russian lad. The development of nails and teeth may also be faulty and one authority questions whether such persons ever get a set of permanent teeth.

The condition is very rare. Perhaps not more than 30 unrelated families having it are known. Most of the cases have been reported from Russia. In the Russian cases the hair was light, while in cases reported from India the hair was dark. Previous studies show that once the condition appears, it will very probably appear in the next generation.

The Kharkov boy's chances of making a living by appearing in circus sideshows is slim, because the Soviet Union does not countenance exhibitions of this sort.—*Science Service.*

Below: Portrait of the modern Russian Jo-Jo. Right: Hairy covering of the body, a congenital defect

Canned Beer

ALTHOUGH "rushing the growler" was a popular pastime in pre-prohibition days, it is a far cry from the old tin can to the modern can in which beer is being sold. Canned beer was introduced recently after several years of investigation by American Can Company, and has become a commercial possibility through two important can-making developments: (1) A can able to withstand an internal pressure of about 85 pounds per square inch; (2) a special inside enamel called "Keglining" by the can company. Other equally important parallel developments were the special beer-can-making machinery and the special method of opening the cans.

A wholly new type of body seam and can end has been worked out, to insure the strength of the beer can against the high pressure of carbon dioxide which is in beer under summer heat without refrigeration. Although the new can body has been ready for some time, the appearance of canned beer on the market had to await the development and testing of proper interior enamel which in character and appearance is a marked departure from traditional enamels.—*A. E. B.*

GALLONS AND GALLONS!

MORE water than is used in the cities of Detroit, Cincinnati, and Washington, D. C., combined is consumed daily in the River Rouge Plant of the Ford Company. The plant's consumption averages 525,000,000 gallons daily.

Photos on Aluminum

A NEW photographic process for reproducing pictures, designs, maps, wood grain, or anything of a similar nature on aluminum has just been announced from Germany. Both the process and the resulting products are remarkable in a number of ways. It is the first time since the invention of photography that an inorganic colloid, aluminum oxide, is used as a carrier for light-sensitive substances.

The SEO process, as it is called, consists of exposure and the development, fixing, and toning operations which are common in photography. However, there is no organic carrier-coating as there is in photography and therefore the SEO photos are more durable. At the same time the oxide coating which is achieved protects the underlying metal against mechanical and chemical influences. It becomes corrosion-proof.

SEO photos are light-proof, weather-proof, water-proof, and fire-proof; in fact, they are fire-proof to such an extent that, after the melting of the aluminum at about 1200 degrees Fahrenheit, the SEO coating does not melt and remains visible and readable. Alcohol, ether, benzol, and other

liquids cannot damage the surface of these photos.

It is suggested that this process may be used for signs and instruction-plates for machines and other devices, wiring diagrams, dials of all kinds, scales for measuring instruments and slide rules, for advertising purposes and for novelty articles; also for maps and plans in public buildings, railroads, or subways, as well as for imitation panels of wood, marble, and other materials.

Swedish Parliament Voting System

THE Swedish Riksdag, or National Parliament, which is 500 years old, has installed a modern electric voting system.

Thanks to this new device, designed and manufactured by the L. M. Ericsson Telephone Company, of Stockholm, the votes of the 150 members of the Senate, or First Chamber, are accurately counted in 20 seconds, and those of the 230 members of the House, or Second Chamber, in 30 seconds.

The voting procedure is as follows: After the Secretary has read the bill in question, the Speaker announces that voting will take place, and presses the button on a control apparatus on his desk. This clears the system. On the desk of each Riksdag member are two buttons, one for voting "Aye," and the other for "Nay." Depending upon the way he votes, the member presses one of the two buttons; if he does not want to vote he presses both buttons. Each button needs to be pressed only a second, and once it is touched the voting cannot be changed to anything but "Not Voting," by pressing the other button. In addition to these buttons, there is a small white lamp on each desk. This is lighted as soon as the member has pressed one or both buttons, indicating that his vote is properly registered.

On one wall of the octagon-shaped Chamber is a large panel, equipped with electric lights. This panel is, in effect, a chart of the room, indicating the seat of each member by means of a small square which bears his name. Above the name are four lamps of varying size and shades. The upper left lamp is large and green-colored, and stands for "Aye"; the upper right lamp is large and tinted red, and represents a "Nay" vote. The lower left lamp is small and white, and, if lighted, shows that the member has refrained from voting, while the lower right lamp is small and red, and stands for "Absent." According to the way in which each member votes, a corresponding light is immediately flashed in the square on the panel. Each vote can be clearly seen from any part of the room, even if the name of the voter cannot be read at a distance.

When the Speaker knows that the voting is finished, he presses the button on his control apparatus, after which no new votes can be registered, and no change made in already cast votes. He then touches another button, upon which the automatic tabulation of the votes begins. Almost instantaneously the result is shown in electric lights on two smaller panels, one on each opposite wall.

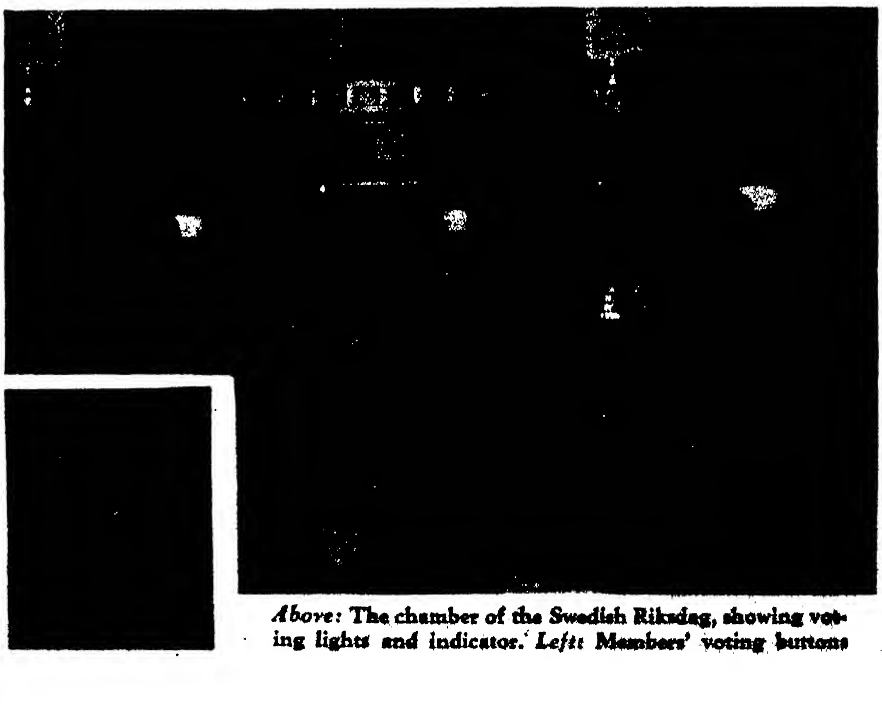
A permanent photographic record is made of each vote by means of yet another panel, a replica in miniature of the one which indicates the desk of each member and the way in which he votes. This is called the "Protocol Table," and is set in a cabinet equipped with a sensitive camera. On this panel all lamps are white, but their positions in their respective squares tell what kind of votes are cast. The film is exposed about one second, dated, and the subject matter of the bill written on a paper which is photographed simultaneously. The names of the voting Riksdag members are also recorded at the time. The film is then developed and the print is bound, serving as a basis for the official protocol.—*Holger Lundbergh.*

Key to Mayan Writing Discovered

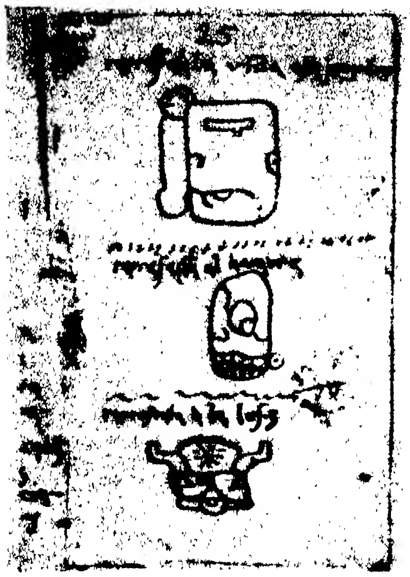
THE key to the hitherto undeciphered Mayan writing, America's greatest prehistoric mystery, was handed to science by Prof. William Gates of Johns Hopkins University.

The Rosetta stone of the Mayan hieroglyphs now revealed is a 300-year old booklet by a forgotten Spaniard. In it are 40 Mayan signs translated into Spanish.

Now archeologists expect to go to the



***Above:* The chamber of the Swedish Riksdag, showing voting lights and indicator. *Left:* Members' voting buttons**



A page from the 300-year old book that gives the key to Mayan writing

famous unread Mayan stela or calendar monuments that dot Yucatan and other Central American areas, and begin more successfully to unravel their unread history. Dates and figure signs have been known in the past, but the writing has remained stubbornly mysterious.

Among the 40 Mayan hieroglyphs identified by the Spaniard are: Light, life, hunger, treasure.

The booklet, just published by the Maya Society, is by a Spaniard named R. Gomesta who lived at the end of the Sixteenth Century in Yucatan. A statement in Gomesta's own handwriting in his book declared that he possessed ancient Indian hieroglyphic books and native friends who interpreted them to him.

The Gomesta manuscript explains another point moot among archeologists. A certain Mayan god, whom scientists have merely lettered as "God B," for want of positive knowledge of his identity, is explained to be the great Itzimná, God of Life, and not Kukulkan, the birdsnake.

The document directs important facets of light upon many other points, and contains some bits of strange and curious lore. There is, for instance, a recipe for making ointment from gum and tiger-grease to put on women sacrificial victims destined for the Sacred Well of Chichen Itza, in Yucatan. This unction was to keep their bodies from swelling afterwards in the sacred waters.—Copyright, *Science Service*.

Hundreds of 'Phone Calls on One-Wire Cable

A NEW cable containing only one wire, centrally located within the sheath, over which it is possible to transmit hundreds of telephone messages at one time, has been developed by the Bell Telephone Laboratories in New York City. This cable, which may profoundly affect future developments in long distance telephony and also provide a television channel "giving size and clarity of vision hitherto unknown," is known as the coaxial cable.

The wire and associated apparatus, it is said, permit the extension of frequency band widths up to and above one million cycles. This broad band of frequencies is divided into many bands 4000 cycles wide, each of which will provide a channel for satisfactory telephone communication. It can readily be seen that by means of this single coaxial conductor hundreds of voice channels can be obtained.

Since the cable can carry all the frequencies from zero to 1,000,000 cycles, or even higher, it makes possible a television channel of "reasonably high definition," communication engineers declare.

A telephone circuit requires two one-way channels, and since the coaxial cable will provide transmission in only one direction, two such cables will be necessary to provide for the customary two-way conversations. Sheaths ranging in diameter from three tenths of an inch to two and a half inches have been used in experimental work with the new invention.

ANTI-SCORBUTIC

CEVITAMIC acid comes forward to take the place of orange juice. This is the name coined for a new tablet used for treating babies with scurvy, and indicates an acid containing C vitamin.

Citrus Wines

WINE can be produced from citrus fruits at a cost of about 32 cents a gallon by a process developed by the Winter Haven (Florida) station of the Department of Agriculture. Made from culls, the wines are prepared by reaming the fruit on rapidly rotating burrs and then straining the juice and fermenting it with a pure culture of wine yeast. Corn sugar is added to increase the sugar content by about 25 percent.

The estimated cost of 32 cents is based on a price of 45 cents a field box for the fruit and a plant investment of 15,000 dollars.

The number of wines that can be made vary from light to heavy, and while these resemble sauterne, sherry, port, and other wines, they have their own characteristics and are not "imitations."—*A. E. B.*

Pepper Weevil Parasites

WHILE one division of the Department of Agriculture is trying to cripple Hawaii's sugar industry, another is receiving substantial co-operation from this same industry. The Hawaiian Sugar Planters Association is attempting to restrain Henry A. Wallace, Secretary of Agriculture, from applying the quotas set up under the Jones-Costigan Act on the basis that these quotas are discriminatory against an integral part of the United States. Under them, Hawaii's sugar sales to the mainland are seriously curtailed while the door is opened wide to Cuban sugar at a greatly reduced duty. But in spite of this situation, the experiment station of the Association is co-operating with the Bureau of Entomology and Plant Quarantine of the Department of Agriculture at Washington, D. C., in supplying parasites of the pepper weevil for experi-

mental purposes in connection with the cotton industry of mainland United States.

Entomologists for the Hawaiian Sugar Planters' Association discovered the parasite in Guatemala while searching for parasites friendly to the sugar industry, and sent several colonies to the Territory of Hawaii. The sugar industry had no particular use for the parasite, and the red pepper has no commercial importance in Hawaii, but following its general policy of extending aid to miscellaneous agriculture in other parts of the United States, the H. S. P. A. experiment station reported the discovery to Washington.

At the request of Lee A. Strong, chief of the federal bureau, colonies of the parasite are to be sent to the Riverside experiment station in California. The pepper weevil is related to the boll weevil, and experiments will be made on the theory that its parasite may possibly have some effect on the cotton boll weevil.

DIGEST OF AVIATION

(Continued from page 242)

formed by the compass bowl and the float respectively. As the float turns, a resistance bridge insures that a current proportional to the angular movement of the compass is produced. This current in turn controls a system of valves admitting oil under pressure on either side of a double acting piston. As the piston moves back and forth, it controls the rudder through a safety spring coupling. This coupling enables the pilot in emergency cases to over-ride the action of the automatic pilot. A similar system is employed for the ailerons, although here a pendulum unit with electric connections gives the initial guidance.

For the elevator control a pitot tube is connected to a diaphragm. When the pressure on the pitot tube increases unduly, the diaphragm so acts that the nose is raised and too steep a dive is prevented.

This, however, does not end the possibilities of the robot, which includes a course setter and a course indicator which are connected with the telecompass. It also provides a rate-of-turn selector which enables the aircraft to make turns of different radii automatically. There is also included an automatic engine speed control. This consists of a small electric motor actuated by a statoscope or rate-of-climb indicator. If altitude is lost, the throttle is automatically opened up by the controller until the altitude for which control has been set is regained.

The Siemens Autopilot has been flown for hundreds of hours, and while no information is given regarding the degree of efficiency in gusty weather, it is claimed that in calm weather the direction is maintained to within plus or minus 2 degrees, the speed within plus or minus 2 miles per hour and the altitude within a pressure range corresponding to only one millimeter of mercury.

A drawback, besides complexity, seems to lie in the weight of the apparatus, which is 275 pounds. The makers respond to this objection by saying that when there is an Autopilot on board there is no need to carry a second pilot, so that the weight of dual controls, a second parachute, and so on, may be avoided.

CURRENT BULLETIN BRIEFS

SUPERVISION EXERCISED BY STATES OVER PRIVATELY CONTROLLED INSTITUTIONS OF HIGHER EDUCATION, by John H. McNeely, gives specific information on the subject and analyzes laws in force regarding such supervision. Bulletin, 1934, No. 8. *Superintendent of Documents, Washington, D. C.—10 cents.*

"FLEX-SET" PREFORMED YELLOW STRAND WIRE ROPE gives information about a newly developed type of wire rope and shows how and why it is superior to other types of cable. Well illustrated and replete with test data. *Write for Bulletin 535A to* SCIENTIFIC AMERICAN, *24 West 40th Street, New York City.—3-cent stamp.*

THE PORT OF PORTLAND COMMISSION, Biennial Report 1933-1934. A book of interesting facts and figures regarding the present status of the Port of Portland and the development work which has been carried out. Several photographs and maps are of particular interest. *The Port of Portland Commission, Portland, Oregon.—Gratis.*

HOW GOOD ARE YOU AT TWISTING AND BENDING? is the title of a little booklet describing a new type of finish for metal which resists stresses of twisting and bending to a remarkable extent. Samples included in the booklet permit the reader to see for himself just how good this new type of metal finish really is. *Write for Bulletin 535B to* SCIENTIFIC AMERICAN, *24 West 40th Street, New York City.—3-cent stamp.*

ANNUAL REPORT OF THE CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE, by Nicholas Murray Butler, Director. This report, covering the work during 1934, is world-wide in scope and concludes with a final report of the Institution. *Carnegie Endowment for International Peace, 405 West 117th Street, New York, N. Y.—Gratis.*

"FULSCOPE" TEMPERATURE CONTROLLERS is something more than an ordinary catalog of indicators. It gives much information on various types of recording instruments for temperature and pressure, and illustrates several special purpose types. *Write for Bulletin 535C to* SCIENTIFIC AMERICAN, *24 West 40th Street, New York City.—3-cent stamp.*

PULLMAN ACCOMMODATIONS tells the story of the services rendered to the traveling public by the Pullman organization. Beautifully illustrated with color plates showing the various types of accommodations available. *The Pullman Company, 79 East Adams Street, Chicago, Illinois.—Gratis.*

RESULTS OF A PROJECT IN HYBRIDIZING POPLARS, by A. B Stout and E. J. Schreiner. Here is an excellent follow-up of our article entitled "Poplars of Promise" which appeared in the March issue. Much technical data is given. Illustrated with striking photographs. *New York Botanical Gardens, New York City.—Gratis.*

Books SELECTED BY THE EDITORS

(*Continued from page* 227)
Cornell University, and for the average intelligent lay reader they will seem neither heavy (with a single exception, which is a bit tough) nor light-weight. This book has plenty of meaty substance, and is an outstanding work which presents a true Eddingtonian cross-section of the problems which are occupying the minds of the world's physicists today. —$3.20 postpaid.—*A. G. I.*

GEMS—HOW TO KNOW AND CUT THEM

By H. L. Thompson

THIS little book contains instructions for cutting gem stones in the home lapidary, and it is practical. All amateur gem stone hobbyists should own a copy of it.—55 cents postpaid.—*A. G. I.*

YOU CAN FIX IT
An Encyclopedia of Home Repairs

By John and Enid Wells

IS your cellar damp? Has your radio gone "haywire"? Does your heating system work properly? Is your washing machine out of "kilter"? Then you need this book. In fact, if any of the thousand and one minor or major troubles around the home fall to your lot for repair, you will find in this 480-page book information on how to fix it; and furthermore, not only how to fix it but, what is often more important, how to locate the trouble. A novel arrangement of chapters is of great assistance in locating any particular piece of information. In many of the chapters there is a "Manufacturers' Section" which gives information on specific types of household equipment. It is impossible in a short review to do justice to the vast range of material covered by this book. All we can say is that it starts out to do a job and does it well.—$2.70 postpaid.—*A. P. P.*

THE SPIRIT OF CHEMISTRY

By Alexander Findlay, Professor of Chemistry, University Aberdeen

"THIS book has been written as a text-book for those students, more especially, who, in the Universities of Great Britain and in the colleges of the United States, in increasingly large numbers, pursue a course in chemistry as an element of general culture rather than as a part of their professional or technical training. Its form and content, therefore, have been chosen so as to make appeal to the imagination and intellectual interests of those who are not destined for a scientific career, but who desire to understand something of the intellectual progress of recent years and to gain some knowledge of a branch of science on which much of our present-day civilization is based."

We find that the author's own description, quoted above from his preface, accurately describes his book, and that this is the kind of book which perhaps best suits the reader who wishes to study chemistry by himself. It is authentic, accurate, solid, meaty, not superficial, yet much more readable than the typical class-room text.—$4.25 postpaid.—*A. G. I.*

ALCOHOL AND ANAESTHESIA

By W. Burridge, D. M., M. A.

THIS little book contains discussions of the action of alcohol on the heart, brain and so on, and argues that alcohol, cocaine, and other drugs do not necessarily do harm even when used habitually. Its author is a professor of physiology. Readers who are physicians or psychologists will be able to grasp most of what he writes, others probably about half.—$1.00 postpaid.—*A. G. I.*

CANOEING WITH THE CREE

By Arnold Sevareid

A TRUE story of thrilling adventure on a 2250-mile canoe trip from Minneapolis to the Atlantic Ocean. Starting in June, two high school graduates made this trip, taking their obstacles as they found them; they battled many long stretches of winding river with the friendly Cree Indians, stopped at outlying Hudson Bay trading posts and for many, many days on end saw no one but themselves. The trip ended the following winter. This record of an amazing journey which had never been accomplished before is illustrated with a series of excellent photographs depicting graphically some of the trials and tribulations of the trip. This is a book which will be enjoyed alike by young and old—by anyone who responds to the thrill of outdoor adventure.—$1.65 postpaid.—*A. P. P.*

NEW LIGHT ON THE MOST ANCIENT EAST

By V. Gordon Childe, B. Litt.

THERE is a demand for a popular book which tells what is now known about the very early millennia in Egypt, Babylonia, Sumeria, and the remarkable new discoveries of an immense Sumerian civilization in India—all previous to the beginnings of written history—and this book by the professor of prehistoric archeology at the University of Edinburgh covers that relatively new ground. In some ways it is not a very satisfactory work. Whether due to the vagueness of our knowledge of these millennia, or to a casual kind of vagueness in the author's presentation of his material, or both, the reader may experience difficulty in deriving from the book a very clearly focused picture. Also, it is hardly a suitable book for "the man in the street," as the preface claims, unless the men in the streets have all previously studied the background of archeology; it reads more like lectures to specializing students. The subject matter dealt with is nearly all actual objects found; their historical interpretation is mainly missing in the book because still mostly missing from human knowledge. There are 301 pages and 134 illustrations. We recommend this book, in the absence of a better one.—$4.20 postpaid.—*A. G. I.*

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

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The SCIENTIFIC AMERICAN DIGEST

COVER

28118/136

SONGS of wild birds in their native habitats are now being recorded by the American Museum-Cornell Ornithological Expedition. (See page 331 of this issue.) Our cover illustration shows one of the sound collectors set up in a wild part of Florida to record the notes of Audubon's caracara. A parabolic reflector serves to gather the sound and concentrate it on a microphone which in turn is connected to the apparatus for recording on movie film. A telescopic sight on the reflector enables the operator to aim the reflector directly at the bird and thus secure greatest efficiency in recording the sound.

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ACROSS THE EDITOR'S DESK

WHEN J. N. Darling, probably better known to the American public as "Ding" of cartoon fame, first took over the job of Chief of the United States Biological Survey, he was in a position to offer great hopes to game conservationists throughout the country. Mr. Darling's proposals were hailed with great acclaim and he was looked to as the one man who could save wild life in the United States for posterity. Now, however, he apparently finds himself in the position of a sincere worker for a cause, severely handicapped by the red tape of politics. For more than a year Mr. Darling has worked faithfully toward the enactment of legislation which would have definite and favorable effects upon wild life conservation. Failure of Congress to include wild life restoration activities in the Works Relief Bill, inaction on legislation favorable to wild life, and general lack of co-operation, now appear to be the only rewards which he has reaped so far. Mr. Darling's position is entirely unenviable and we sincerely sympathize with him. He is writing for SCIENTIFIC AMERICAN an article dealing with the subject of game conservation and this is scheduled for early publication.

●

"UNDER a high powered microscope, the radiating surface of the firefly presents a gorgeous display of pyrotechnics. After the eye becomes dark adapted, one sees a soft glow broken here and there by bright flashes at irregular intervals and climaxed finally by a brilliant flash coming from the whole surface." Thus Professor W. J. Parlin of Dickinson College describes the light-source of a firefly in his short article telling how he measured the candle-power of the illumination given off by this well known insect. Professor Parlin's article is scheduled for publication next month.

●

THE interest which readers of SCIENTIFIC AMERICAN showed in a series of articles on telepathy and tests for telepathy, which appeared some months ago, assures a welcome reception to an article on the same subject which has just been prepared for us by Dr. J. B. Rhine, Associate Professor of Psychology at Duke University. A first report of Dr. Rhine's work was written by our friend, the late Dr. Walter Franklin Prince and published in our July 1934 number. Dr. Rhine has continued his experimental work in telepathy and clairvoyance, both with persons in the normal state and with a well known British trance medium, Mrs. Eileen J. Garrett. In an early issue Dr. Rhine will tell of the results which were obtained in the experiments conducted with the assistance of Mrs. Garrett. Meritorious scientific research such as this, conducted in a field of which little is known, is certain to uncover eventually the reasons for certain phenomena which up to the present time are considered unexplainable. In Dr. Rhine's article is given an excellent summation which endeavors to answer many of the queries which will naturally arise in the mind of the reader.

COMING

¶ J. N. ("Ding") Darling, on the Aspects of Game Conservation Today.

¶ "How Bright Is a Lightning Bug?" by Professor W. J. Parlin.

¶ Dr. J. B. Rhine on Telepathy and Clairvoyance as Demonstrated by a Trance Medium.

¶ Glands and Their Effect on Personality, by Dr. R. G. Hoskins.

¶ "Fight Corrosion," by Philip H. Smith.

¶ The Story of the Subsistence Homesteader, by John Herrick.

●

PERSONALITY is one factor which has so far successfully defied definition. In probing the whole subject of personality, Dr. R. G. Hoskins, Director of Research, Harvard Medical School, has made it possible to align certain phases of personality definitely with the glands of the body. An article to be published soon tells of these glands and of their effects upon certain bodily functions. The correlation between body functions and personality is so clearly drawn in Dr. Hoskins' article that the reader is given a definite picture of personality as it is determined by glandular functions.

●

NEXT month Philip H. Smith, whose articles on various phases of industry have met with wide acclaim, will write upon the broad subject of copper and copper alloys. Of vital importance to industry are corrosion and the struggles which have been made to combat it. Under the title of "Fight Corrosion," Mr. Smith draws a clear-cut word picture of copper and its present-day place in industry. The multitude of uses to which copper and its alloys can be put and the possibilities of future commercial development are so wide-spread that we cannot even hint at them here. Our only suggestion is that you should not miss Mr. Smith's next article.

●

MUCH has been written in the newspapers and elsewhere about "going back to the land" in an endeavor to relieve some of the effects of business depressions. Of a piece with the "back to the land" movement is the subject of subsistence homesteading, which, however, is something more; it is living *on* the land rather than going *back* to it. Just what forms the background of subsistence homesteading and the economic effect which it may have is clearly told in an article by John Herrick, Assistant to the Manager, Federal Subsistence Homesteads Corporation, to be published shortly. Mr. Herrick outlines the need for subsistence homesteading for hundreds of thousands of people, what it can do for them, and what it can do for the country in general. Here indeed is a new frontier waiting for intensive development and the development is sure to come if present plans can be carried to completion.

Editor and Publisher

Books SELECTED BY THE EDITORS

FROM GALILEO TO COSMIC RAYS

By Harvey Brace Lemon, Ph.D., Prof. Physics Univ. Chicago

THIS book is something entirely new under the sun and is called "a new look at physics" by its author, who is a widely known teacher. Its most notable feature is the effort that has been made to avoid all the earmarks of the old stuffy textbooks—it does not look and is not written like a textbook. It does not even smell like one. It has reading continuity and it reads more like a talk than a lesson—in fact, many of the old school doubtless would label it physics with a jazz accompaniment, especially because of the innumerable humorous marginal sketches intended to brighten the treatment. It covers both classic and modern physics in 440 pages, with 100 plates and a million sketches, more or less. But let the reader put aside, if he has it, the idea that this book presents "physics made easy," a thing which can't be done. The book is full of hard work.—$5.20 postpaid.—*A. G. I.*

DESIGN IN WOODWORK

By Percy A. Wells

GOOD taste and an artistic sense as applied to home craftsmanship constitute the keynote of this little book. The reader is shown the right and wrong way of designing things to be made of wood. A series of 46 halftone plates shows some of the really fine looking furniture that is within reach of the average home craftsman.—$2.15 postpaid.—*A. P. P.*

NEW MINDS FOR OLD

By Esmé Wingfield-Stratford

WE approached this book with some misgivings for there have been so many so-called mental training books published in recent years that we have become somewhat cynical. We found, however, that this is a serious attempt to arrive at a method of improving the mind principally by bringing order out of disorder and developing the memory, through which improvement future actions of the reader may be controlled. While some of the chapters may sound as though the author expects to develop his hearers through the mysticism of ancient India or present-day faith healing, we find that these chapters are necessary to give proper balance and perspective to the subject. One reading should be a boon to the man whose thought processes are disordered by tension of today's stress and strain; more complete study should result in marked mental improvement.—$3.20 postpaid. —*F. D. M.*

METALLIC ARC WELDING

By H. Harris, Ph.D.

IN recent years arc welding has made such rapid strides both in manufacture and in structural engineering that a complete treatise of this sort finds an important place in the libraries of engineers, job foremen, and even of the mechanic who does the actual job. Its 193 pages cover the whole field of arc welding, beginning with a discussion of the theory of the electric arc, and proceeds to explain the various types of welding, welding equipment, electrodes, alloys, influence of gases on steel and weld metal, arc welding of various alloys, and application of arc welding to various products and structures. Printed on glossy paper, well illustrated with diagrams, photographs, and photomicrographs.—$6.20 postpaid.—*F. D. M.*

SCIENCE AND SOCIAL NEEDS

By Julian Huxley

JULIAN HUXLEY has made an extraordinary tour of Great Britain, visiting research laboratories all over the country, in order to ascertain, if possible, the influence of scientific discovery on our lives. In this book he reveals the result of his investigations, and explains to what extent scientific research is catering to the needs of the people, not only as regards its industrial applications, but also as regards the current problems of health, education, housing, the menace of war, and so on. He found that science has made tremendous strides in its development as a social function intimately linked with human destiny, but that there is also an appalling lack of broad social outlook in both the scientific specialist and the layman. Because he maintains that it is essential that everyone understand the interactive nature of science and society, and to support his conviction that the true purpose of science is to serve the needs of humanity, Professor Huxley offers many stimulating suggestions for bridging the wide gap between scientific knowledge and its practical application.—$2.90 postpaid.

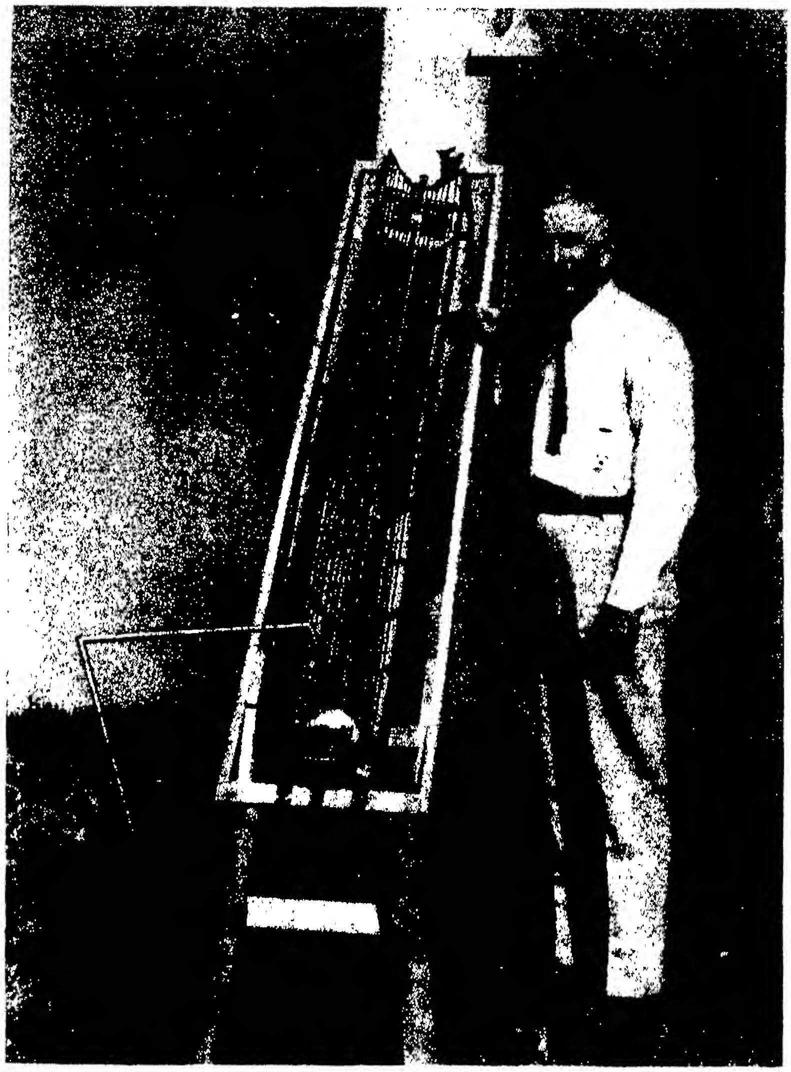
ARMS AND MUNITIONS

Compiled and edited by Joseph H. Baccus

IN this day of excited talk of war, of war profiteers, of munitions investigations, and Federal laws intended to eliminate the financial attractions of warfare, this book comes as a distinct aid to those who argue on any side of these questions. As Volume I of the Pi Kappa Delta Series, it is called by the publishers "The University Debater's Help Book." And it is just that since it is composed chiefly of abstracts from the

(Please turn to page 333)

Personalities in Science



Science Service Photo

DR. CHARLES G. ABBOT

DR. CHARLES G. ABBOT, head of the famous old Smithsonian Institution, is an astrophysicist, and is best known to other scientists as an investigator in the realm of solar physics. To scientifically inclined laymen he is known widely as the author of a standard semi-popular book entitled "The Sun," and to the newspaper reading public he is the scientist who has made experiments with the sun's radiation as a source of heat for running a true "fireless cooker" of the kind shown here.

In the chapter on "Utilizing Solar Energy," in his book, "The Sun," Dr. Abbot describes various attempts that have been made to derive energy applicably and economically—which means competably with other familiar sources of energy—and includes a picture of a solar cooker which he constructed some years ago and set up outside his residence on top of Mount Wilson, California. The same cooker has become somewhat famous, pictures of it having been reproduced in scores of books, magazines, and newspapers during the past two decades or so. It was 7½ by 12 feet in breadth and length, and consisted of aluminum covered steel sheets bent to parabolic section, which focused the sun's heat on a blackened, 1½-inch metal tube, through which oil, the heat-absorbing and conveying medium, was circulated to the ovens. Bread was baked and other general cooking was done with it. The scientist was merely combining some interesting fun with something of immediate utility, and possibly of later applicability.

The solar cooker shown here is a sort of "pocket edition" of the earlier one just described, but it has a higher efficiency and greater refinement. Instead of the single bent sheet of iron, which was used previously, this one employs 12 long, narrow mirrors, arranged individually in such a way that together they reflect the sun's radiation to their common focus. At this focus is a glass tube containing black oil. This tube is surrounded by a second sheath, with a vacuum between the two tubes. This permits the sun's radiant heat to reach the oil, but prevents partial loss of the received heat by ordinary convection and conduction. There is a reservoir of hot oil a short distance away. The entire cooker is propped up to face the sunlight, and provision is made to keep the mirrors facing the sun throughout the day.

Men of science and engineers, who do not overlook practical factors, are not so inclined to make glowing predictions about the cheap recovery of direct solar energy as some others. It is possible to make use of solar energy in some special circumstances to fair advantage, but there seems to be a wide difference or spread between (1) the glowing predictions and promises contained in, or in one way or another implied by, certain magazine and Sunday supplement articles which have appeared at quite regular intervals down through the years, and doubtless will continue to appear because they at least make good reading, and (2) the actual development of solar energy utilization. For this spread there must be some reason. Either the whole thing is a humbug or engineers and scientists are a stupid lot. It is neither. It is quite possible to recover solar energy, sometimes economically, but the installation must compete with other sources of power. It seldom can.

But this does not prevent a scientist from having a little fun with a most interesting scientific plaything. And the same fun may someday turn out to have had more significance than the present participants ever thought.

Science Service Photo

WAS THIS GAS CLOUD ONCE A STAR?

ARE some of the diffuse types of nebulae, which consist of highly rarefied gases still in irregular internal turmoil, simply the later stages of new stars that explode, like the present new star in Hercules? At Mt. Wilson Observatory Dr. Gustaf Strömberg thinks the Crab Nebula in Taurus (shown above) represents a case of this kind, and from a study of its spectrum concludes that the explosion took place about 900 years ago. Is it a coincidence that Chinese astronomers recorded a new star in the same spot 900 years ago? The circumstances look suspicious.

Southern progress in utilizing waste materials: plant producing turpentine, rosin, pine oil, from pine stumps

Industrial Dixie

Scientific Research Aids the South . . . Industries Growing . . . South Now Employs 20 Percent of Nation's Factory Workers . . . Promising Future

By DANIEL C. ROPER
Secretary, Department of Commerce

CERTAIN basic factors—the increasing availability of cheap electric power and the relatively low living costs—place the South in a position especially advantageous for industrial development. These factors, together with its proximity to sources of raw material, particularly cotton, indicate, in the light of its past record, a continuing advance in its industrialization.

Scientific research is doing much to assist in the development of industries in the South. While these trends have not as yet assumed major proportions, they are contributary factors of increasing consequence.

For instance, as a result of scientific research in developing the lumber industry through the South, modern pulp and paper mills have sprung up in many sections during the last ten to fifteen years and are doing well. Research has proved that spruce is not the only wood that can be used for the manufacture of rayon and that other southern wood growths could be satisfactorily used for paper manufacture. As the result of such studies, encouraged by the Forest Products Division of the Department of Commerce, much progress has been made in wood construction technique.

ANOTHER industry that has forged to the front in the South is canning, particularly the canning of citrus fruits and fruit juices. This has come as the result both of scientific research and commercial demand. The first figures in these lines were gathered by the Foodstuffs Division of the Bureau of Foreign and Domestic Commerce, Department of Commerce, in 1920. Since that time the upward curve of southern production of canned grapefruit, and orange and grapefruit juice has been steady. Success with these products prompted further experiments in the canning of peas and tomatoes in the Lower Rio Grande Valley region of Texas and these are proving to be very successful.

Chemistry has played a very important part in the industrialization of the South. Chemical engineers, utilizing this section's abundant natural resources, have been able to replace much of their loss in naval stores with paper, cellulose, nitrates, bromine, alkali products, wood preservatives, protective coatings, and other chemical manufactures. In 1934 more than 20,000,000 dollars was invested in these last named enterprises in the South.

The recent development of the tung oil industry is another example of the partnership between science, agriculture, and business. Tung oil is extracted from the seed of the tung tree which is native to central and southern China, but which science has successfully

TABLE I—GROWTH IN POPULATION AND INDUSTRY

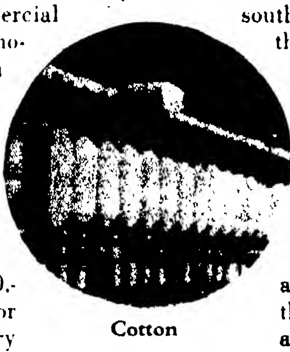
The South in comparison with the United States: 1869-1933

POPULATION	1870	1880	1890	1900	1910	1920	1930	1933[1]
United States	38,558,371	50,155,783	62,947,714	75,994,575	91,972,266	105,710,620	122,775,046	125,698,000
The South	12,288,020	16,516,568	20,028,059	24,523,527	29,389,330	33,125,803	37,857,633	38,665,000
Percent of U. S.	31.9	32.9	31.8	32.3	32.0	31.3	30.8	30.8
MANUFACTURES	1869[2]	1879[2]	1889[2]	1899	1909	1919	1929	1933
Number of wage earners:[3]								
United States	2,053,996	2,732,595	4,251,535	4,712,763	6,615,046	9,096,372	8,838,743	6,055,736
The South	245,725	301,677	550,654	748,940	1,129,307	1,431,682	1,587,260	1,227,475
Percent of U. S.	12.0	11.0	13.0	15.9	17.1	15.7	18.0	20.3
Wage earners—percent of total population:								
United States	5.3	5.4	6.8	6.2	7.2	8.6	7.2	4.8
The South	2.0	1.8	2.7	3.1	3.8	4.3	4.2	3.2
Value added by manufacture in thousands of dollars:[4]								
United States	1,395,119	1,972,756	4,210,365	4,831,075	8,529,261	25,041,698	31,885,284	14,538,018
The South	126,620	172,613	442,728	563,497	1,128,819	3,253,332	4,333,112	2,231,305
Percent of U. S.	9.1	8.7	10.5	11.7	13.2	13.0	13.6	15.3
ELECTRIC LIGHT AND POWER					1902[5]	1912	1922	1932
Number of employees:[6]								
United States					30,326	79,335	150,762	244,573
The South					3,904	10,398	20,932	43,623
Percent of U. S.					12.9	13.1	13.9	17.8
Thousands of kilowatt-hours:								
United States					2,507,051	11,569,110	40,291,536	79,657,467
The South					256,896	1,191,509	6,250,661	16,760,955
Percent of U. S.					10.2	10.3	15.5	21.0

[1]Estimated.
[2]Figures for 1889 and earlier years include data for "hand and neighborhood industries" (blacksmithing, carpentry, custom tailoring, etc.) and therefore are not strictly comparable with those for 1899 and later years, which do not include such data.
[3]Not including salaried employees.
[4]Value of products less cost of materials, containers, fuel, and purchased electric energy. This is a rough measure of the net new value created by the manufacturing processes.
[5]No data for earlier years.
[6]Total salaried employees and wage earners.

propagated in the South. This oil, because of its waterproofing qualities, is much used in the manufacture of varnish and in the manufacture of insulating compounds for the electrical industry. It is likewise used as an ingredient of some automobile brake linings. The American tung oil has been found superior to that of China.

Another chemical which formerly had to be imported to this country is bromine, used principally in making dyes and other like commercial products, and high-grade motor fuel. A plant has been established on the coast of North Carolina which is now extracting bromine from sea water. It is reported that 15,000 pounds of this valuable chemical are extracted and marketed daily from 37,000,000 gallons of sea water, or about one pound to every 2500 gallons of water treated. For these factual reasons, the future of southern manufacturing seems propitious in many lines.



Cotton

The South, with slightly more than 30 percent of the country's population, now employs about 20 percent of the entire country's factory workers. The South, as the term is used in this article, comprises the region lying east of the Mississippi River and south of Mason and Dixon's line (the southern boundary of Pennsylvania) and the Ohio River, together with four states west of the Mississippi, namely, Arkansas, Louisiana, Oklahoma, and Texas—a total of 16 states and the District of Columbia. As compared with the late seventies—say a half a century ago—when the southern states accounted for about 33 percent of the population and only 11 percent of the wage earners in manufactures, this betokens a noteworthy degree of progress in industrialization, although the South is still predominantly an agricultural region.

In the light of these facts, it is interesting to note that a century and a quarter ago, in 1810, when the first census of manufactures was taken, and when somewhat less than half the population of the country lived in the region south of Mason and Dixon's line, that region contributed approximately one third of the value of commodities manufactured in the United States. Virginia, with a total output somewhat above that of New York, then outranked all other states except Massachusetts and Pennsylvania, and was the leading state in cotton and flax manufactures. (The metal products of Virginia included 1081 swords, valued at 5405 dollars—this being the total production of swords in the entire United States according to the census of 1810.)

Seventy years later, about a decade and a half after the close of the Civil War, when manufacturing was done mainly in factories rather than in homes and in neighborhood shops—as in 1810—the South's share of the nation's industry total had dropped to less than 9 percent, as measured by "value added by manufacture" (see footnote 4, Table 1), and 11 percent as measured by number of workers employed. From that time (1879) onward the census records show, decade by decade, substantial increases in the amount of manufacturing done in the South, until in 1929 the southern factories employed nearly 1,600,000 workers, with products valued at more than ten billion dollars, and contributed a net of four and one-third billions to the nation's wealth. During the following four years the South shared in the general industrial depression, but it is noteworthy that its percentage of the nation's factory workers increased from 18.0 in 1929 to 20.3 in 1933, and that during the same period its percentage of the total "value added by manufacture" rose from 13.6 to 15.3 percent.

TABLE 1 sets out in condensed form the record of the South's progress in industrialization during the 64-year period beginning with 1869.

The most striking increase shown in Table 1 is in the electric light and power industry, where employment rose from 3904 in 1902 to 43,623 in 1932, and production increased from 257,-

TABLE II-

This table presents statisti

INDUSTRY	NUMBER OF ESTABLISHMENTS[1]		
	1899	1929	1933
All industries in the South	36,376	41,296	24,48
LEADING INDUSTRIES			
Cotton goods	417	821	70
Lumber and timber products not elsewhere classified	14,171	8,701	2,02
Knit goods	82	387	32
Railroad repair shops, steam	308	449	41
Cigars and cigarettes	1,184	188	9
Steel-works and rolling-mill products	38	48	4
Rayon and allied products	—	14	1

[1]The figures for 1899 cover all establishments reporting products v ued at $500 or more, whereas the corresponding minimum limit for 19 and 1933 was $5,000. This change materially reduced the number establishments covered by the census, but had only a negligible effect the figures for wage earners, value added by manufacture, and horsepow

000,000 to 16,761,000,000 kilowatt-hours. During this 30-year period the South's proportion of the total output of electric energy in the United States more than doubled—increasing from 10.2 percent to 21 percent.

The increase in number of workers employed does not afford a true indication of the actual increase in the amount of manufacturing. The industrial growth of a nation or of a region can be measured adequately only by a production index representing *quantities*. No such index has been prepared for the South or for any other section of the United States, but the results of a careful study of the manufactures-census figures for the United States as a whole indicate that the progress in mechanization of factory equipment during the 30-year period from 1899 to 1929 had brought about an increase of 65 percent in the average output per wage-earner, and that four years later this average was 50 percent above that for 1899. If it be assumed that the output per worker in the South has increased in like proportion, the quantity of manufactured goods made in the South was about three and one-half times as large in 1933 as in 1899. Moreover, it would not seem unreasonable to assume that the percentage of increase in this respect has been somewhat greater in the South than in the United States as a whole, for the reason that in those industries that have spread to the South during recent years mechanization has probably reached a somewhat higher level than elsewhere, since such changes would not necessitate the replacement of obsolescent equipment. The reluctance to abandon old equipment has doubtless retarded mechanization in some of the older industrial centers.

SOME measure of the increase in factory mechanization is afforded by the figures given in the last four columns of Table 2, from which it will be seen that the horsepower rating of the prime movers and electric motors used to drive factory machinery in the South increased from 1,715,000 in 1899 to 8,067,000 in 1929. This is an increase of approximately 370 percent during a period within which the gain recorded for wage-earner employment amounted to about 110 percent.

©Bachrach

Hon. Daniel C. Roper

Table 2 measures the growth, since the beginning of the present century, of the seven leading industries in the South. These seven industries, each of which employed more than 30,000 factory workers, together accounted for nearly half of the total number of factory wage-earners reported for the South at the 1933 census.

The cotton goods industry, as is well known, is by far the most important in the South. The record of cotton-mill development dates back to 1880, in which year the cotton-producing states operated only a little more than five percent of the spindles in the United States and consumed only about a quarter of a million bales of cotton, or approximately one seventh of the total American consumption. The increase in the number of spindles in the South was gradual until about 1895, but has been more rapid since then, until in 1927 the number of spindles in the cotton-growing states (including California) exceeded the number in the remainder of the United States. With only one exception—1905—each year from 1880 onward has shown an increase in the number of spindles in the South; and, beginning with 1922, each year has shown a decrease in the number of spindles in the remainder of the country.

Turning to the record of cotton consumption, we find that in 1911 the cotton-growing states consumed slightly more cotton than all other states and that the margin increased until in 1929 they accounted for approximately three fourths and in 1934 practically four fifths of all the cotton consumed in the United States.

The most striking rate of growth recorded for any southern industry, however, appears for knit goods, in which more than nine times as many wage-earners were employed in the South in 1933 as in 1899—67,000 in the later year as against 7000 in the earlier. The rayon industry is another southern industry which has developed rapidly in recent years. This industry (unknown in 1899) employed 24,000 southern factory workers in 1929 and 30,000 in 1933.

AT the beginning of the century, the leading industrial state of the South, as measured by factory employment, was Maryland, followed in order by Georgia and North Carolina. Ten years later North Carolina led all other southern states in factory employment; and in 1919 and subsequent years North Carolina has been well in the lead of all other states in the South, both in employment and in value added by manufacture. In 1929, the peak year, North Carolina employed nearly 210,000 wage-earners, or more than 13 percent of the total for the South, and contributed 693,000,000 dollars, or 16 percent, of the southern total for value added by manufacture. The marked growth in manufacturing activity in this state is due in considerable part to the development of the cotton textile industry, in which nearly 92,000 workers, or about 44 percent of the stat 's total in all industries, were employed.

(*Please turn to page* 332)

LEADING INDUSTRIES IN THE SOUTH: 1899, 1929, AND 1933

for those industries, 7 in number, each of which employed more than 30,000 wage-earners in the South in 1933

Wage-earners[2] (Average for the year)						Value added by manufacture[3]						Horsepower[4]			
Number			Percent of U. S. Total[5]			Amount in thousands of dollars			Percent of U. S. Total[5]			Amount		Percent of U. S. Total[5]	
1899	1929	1933	1899	1929	1933	1899	1929	1933	1899	1929	1933	1899	1929	1899	1929
748,940	1,587,260	1,227,475	15.9	18.0	20.3	563,497	4,333,112	2,231,305	11.7	13.6	15.3	1,714,603	8,066,924	15.2	18.8
102,593	275,280	274,372	34.4	64.8	72.3	41,344	372,983	256,078	26.0	59.6	66.6	223,820	1,332,641	27.8	58.7
120,715	226,123	99,531	42.6	54.0	52.6	87,242	371,592	92,124	35.0	43.5	40.6	571,513	850,286	35.4	42.8
7,401	58,906	67,447	8.9	28.3	35.6	2,620	82,267	73,860	5.9	18.6	28.3	4,116	47,388	7.1	26.1
39,990	104,366	62,168	23.0	28.3	28.2	23,219	175,997	77,117	21.4	26.3	27.1	19,952	347,862	20.1	32.3
16,030	40,779	38,079	17.4	38.7	49.4	[6]15,399	[6]494,417	[6]146,637	15.1	69.6	73.0	993	33,492	20.7	67.6
12,573	42,092	35,422	6.9	10.7	12.8	11,675	138,774	61,954	5.7	9.5	13.7	[7]191,215	[7]762,551	11.4	10.1
—	24,090	30,094	—	61.6	67.9	—	67,170	81,019	—	57.8	71.8	—	143,111	—	73.1

[2]Not including salaried employees. [3]Value of products less cost of materials, containers, fuel, and purchased electric energy.
[4]Rated horsepower capacity of prime movers plus that of electric motors driven by purchased energy. No data collected for 1933.
[5]The percentages for "All industries in the South" represent the South's share of the United States totals for all industries, and those for the leading industries represent the South's share of the United States totals for the respective industries.
[6]Figures for 1899 and 1929 not comparable with those for 1933. [7]Includes horsepower for the blast furnace industry.

Courtesy Atwater-Kent

WORLD-WIDE RADIO

All-Wave Receivers

By M. L. MUHLEMAN*

It is doubtful if international short-wave broadcasting would be the success it is today were it not for the vast improvements made in all-wave receivers. The complexity of circuits and circuit functions in these receivers is truly amazing. It is almost unbelievable that the feeble impulses picked up by the receiving aerial can survive the electrical ordeal through which they must pass before emerging from the loudspeaker. Yet the gymnastics to which the impulses are subjected account for the remarkable results that may be obtained from an all-wave receiver.

What happens to these feeble impulses? They are routed through two of a bank of some 12 to 15 coils and switch contacts, filtered during this passage, then pre-amplified at their own wavelength, again filtered, and thence fed to a converter tube. In the circuit of the converter tube, the impulses are mixed with a locally-generated group of impulses, modulated, and made to assume an entirely different wavelength than the original. The converted impulses are then re-amplified at the new wavelength, demodulated, amplified again at an audible frequency and finally fed to the loudspeaker. Moreover, during the demodulating process, a percentage of the impulses are tapped off through a separate circuit network, filtered, and used for the purpose of automatically controlling the sensitivity of the receiver. Yet, for all of this electrical pummeling, the impulses are heard a fraction of a second after their transmission from a station possibly 6000 miles distant, and remain almost an exact counterpart of the original.

Pre-amplification in all-wave receivers is a comparatively recent refinement. It contributes more to the efficient functioning of a receiver than any other component, and its importance cannot be overemphasized. The pre-amplifier bears resemblance to an optical system composed of magnifying lenses and color filters. It amplifies the intercepted signal and, through its selective properties, permits only the one signal to pass through. Its selective properties also eliminate "image interference," that peculiar property of a superheterodyne receiver of repeating a signal at some other point on the tuning dial—a point where there may very well be another station. But most important of all is that property of the pre-amplifier which leads to a much greater amplification of the signal than of local noise, with the result that the "usable" sensitivity of the receiver as a whole is considerably increased. That is, it makes possible the reception of a weak signal that would ordinarily be lost in a highly objectionable noise background.

Next in importance to the pre-amplifier are the new types of tuning scales and dial drives incorporated in modern all-wave receivers. The dials and the drives assume different forms, but in principle they are all much the same.

It is a curious fact that the lower or shorter the wavelength, the more difficult it becomes to tune in a station. Tuning in the standard broadcast band is a simple matter, but at 49, 31, 25, and 19 meters, tuning is a hopeless task unless special provisions are made to reduce the rate of motion of the dial or dial pointer with respect to the rate of motion of the drive knob.

In the earlier all-wave receivers, the dial drives have two ratios: one of about 10 to 1 for tuning in the standard broadcast band, and a second of about 20 or 30 to 1 for tuning in the short-wave bands. In modern all-wave receivers, the short-wave dial-drive vernier ratios run as high as 135 to 1, with the average in the vicinity of 50 or 60 to 1.

This mechanical reduction in movement offers almost the same ease in tuning as the 10 to 1 ratio provides in the standard broadcast band. The one drawback lies in the fact that short-wave stations may appear on the dial only a hair's breadth apart, with the result that station logging is difficult. To obviate this inconvenience, some manufacturers have added to the dial a supplementary scale and pointer, much like the second hand on a clock.

In effect, this is equivalent to "spreading" a waveband. For example, the 15-megacycle (19-meter) band occupies only two divisions on the average all-wave receiver dial scale. But the supplementary pointer forming the "band spread" travels through approximately 60 degrees or divisions as the main pointer is covering the two scale divisions encompassing the entire 19-meter band. Thus it is possible to log stations in much the same manner as one takes readings with a micrometer.

The third most important feature in an all-wave receiver is the automatic volume control system. This maintains the short-wave signal at a constant value. As the signal grows weak, the sensitivity of the receiver is automatically increased; as the signal grows stronger again, the sensitivity of the receiver is automatically reduced.

●

As a guide to our readers in the selection of all-wave receivers, we have prepared a list of representative sets by leading manufacturers, giving tuning range, number of tubes, special features, cabinet type, and price. This list will be sent on request. Stamp, please, for mailing.—The Editor.

Courtesy Crosley

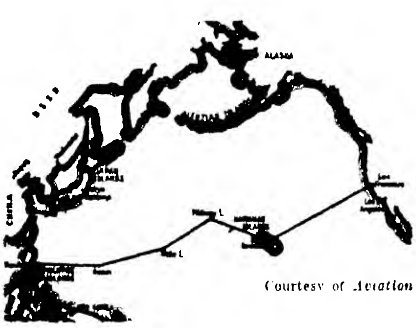
*Editor, Communication and Broadcast Engineering, Radio Engineering, (Radio) Service.

OUR POINT OF VIEW

Transpacific

THAT the American pioneering spirit is by no means dead is proved by the announcement of a dramatic plan to establish a transpacific air service during 1935. The foresight and determination which enabled our ancestors to carve a world power out of a wilderness lives again in the minds which have envisioned giant Clipper planes in a scheduled transport service to the Hawaiian Islands and the Philippines—and have laid the groundwork which will make such a service possible.

These pioneers of the Transpacific Division of Pan American Airways have planned carefully and well, and are deserving of the highest praise for their resourcefulness. They still have a large part of the job ahead—test flights with the Clippers as flying laboratories, airports to be built on small and lonely islands, trips by a steamship specially equipped to carry a group of aviation experts—but no single phase of it has been slighted or left to chance. Backed by a huge fund of aeronautical data



Courtesy of *Aviation*

accumulated by thorough-going research, and imbued with the pioneer spirit so essential to overcoming obstacles as they arise, Pan American is steadily forging ahead.

The extraordinary achievement which is being aimed at is an overnight service from San Francisco to Honolulu (2410 miles) and four daylight flights to Manila in the following stages: To Midway Island (1320 miles); to Wake Island (1260 miles); to Guam (1500 miles); and to Manila (1600 miles).

The same type of planning which has made possible regular aerial service over the Caribbean Sea to South America and along both coasts of that continent will be brought to bear on the transpacific problems. Highly perfected power plants and carefully designed aircraft, coupled with a well-rounded knowledge of the multitude of factors which are involved in successful air transport operation, all point to the probability of success.

Thus does science furnish the stuff of which dreams are made. Only a generation ago talk of a transpacific air service would have been considered as the mouthings of a maniac, or at least of one who preferred visions to realities. But man's conquest of the air has provided the wherewithal, and hard-headed business men are pushing to completion the fulfilment of a dream—but a dream founded on the solid rock of accomplishment in the past, now being projected into the future.

Alcoholic Gasoline

THEY'RE at it again! The "Soak Everybody" boys, having flooded the nation with their economic nostrums which, somehow, usually hit hardest the purses of those they are designed to help, again propose helping the grain farmer at the expense of motorists, or, to be exact, all operators of gasoline engines. The attempt made three years ago by pseudo-economists or out-and-out vote-exploiting politicians to care for a glut of farm products by compelling use of farm-product alcohol in all gasoline, was defeated by incontrovertible scientific facts. Yet at the moment, both houses in South Dakota have passed a measure intended in this manner to relieve agricultural distress; and Iowa, Minnesota, Nebraska, Idaho, and California would likewise fly in the face of facts, for they have similar measures pending.

The United States Bureau of Standards proved—in our opinion, conclusively—that the economic reasoning of the alcohol-gasoline advocates was untenable. Others, with an equally impressive body of evidence, condemned the thesis on both economic and engineering grounds. Yet this bête noir of logic and common sense is at large again to delude gullible constituencies. Some of the salient facts are, therefore, worth iteration.

With a mixture of 90 percent gasoline and 10 percent alcohol:

1—Engine performance will be less efficient and mileage will drop—unless carbureters and engines are redesigned, and this would be so costly as to be unworthy of a moment's consideration. 2—There is no known way to prevent absorption of water by the mixture in all the handling between producer and consumer; alcohol is irremediably hygroscopic. 3—Alcohol can not be produced cheaply, and its addition to gasoline would increase the price of the inferior fuel two to three cents per gallon. 4—Since farmers use 25 percent of all the gasoline we produce, the above-mentioned penalties attached to this particular "farm relief" would leave farmers but little, if any, profit from its operation. 5—There is no real surplus of usable (alcohol producing) farm products now, so the ethyl alcohol—not to be confused with gasoline containing tetraethyl lead now on the market—to be used would take up only farm wastes and unmarketable fruits and potatoes. While this last fact might seem climactic, there is yet a powerful economic argument against the scheme. 6—Grain (ethyl) alcohol can be made from petroleum by cracking and even from lumber wastes by the magic of chemistry. Sensibly, therefore, lumber and oil men would command a sizeable share of the profits and help abort the relief feature very quickly.

Convincing though these facts may be to thinking men, the demagogs will not listen. Theirs is a personal purpose, not to be balked by mere science or the innate sanity of the people—a personal purpose to exploit human misery, as someone so aptly phrased it. And they will continue their pretense of aiding so long as it attracts the votes of the unthinking mass. In high offices and low, theory and experiment are the order of the day, and the long view unimportant. Ensuing poverty, radicalism, chaos matter not: "After us, the deluge." Handouts, doles, anything to undermine character: and every day we get closer to Lenin than Lincoln. No one seems to have thought of the simple expedient of giving business, industry, science, and American initiative a chance to assure their own survival—*and* prosperity. (Other nations have, however, and are seeing the light while we still are at the bottom of the pit.) Such a measure for rehabilitation would demand cutting the shackles of uncertainty—a difficult job for the devious lariat-wielding politicians and one which might show up many of them as superfluous parasites.

Seemingly, we have digressed and run into the field of politics which we should eschew. Actually, ours is a plea for fewer excursions by our elected representatives into fields of science in which they are incompetent, of which they are ignorant, and to which they apply so few grains of common sense.

Back to Prosperity With Housing

Intense Housing Activity Needed . . . Jobs for All . . . Billions Will Go Into Circulation . . . Financing Simple and Easily Arranged . . . Insured Mortgages

By JAMES A. MOFFETT
Federal Housing Administrator

(In Two Parts. Part 2)

WHY the National Housing Act at once starts America back to prosperity, as pointed out last month, is easily demonstrated:

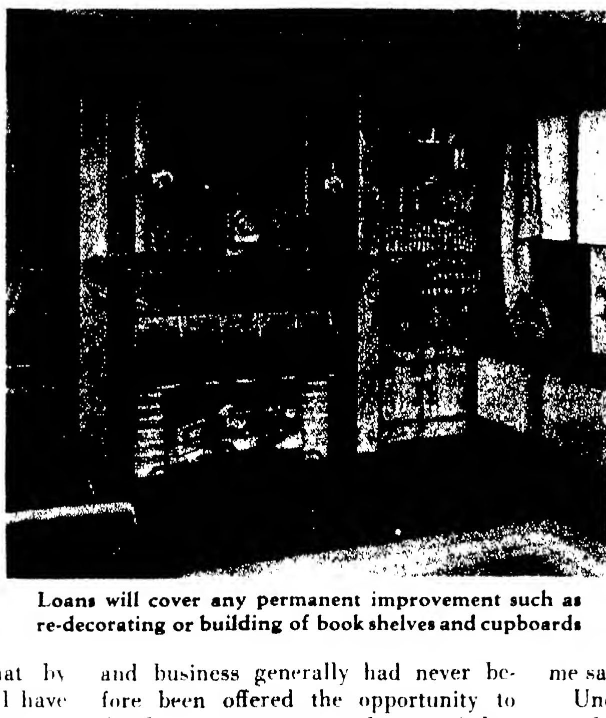
Authorities on the movement and behavior of money have found that out of every hundred dollars spent on home construction or repair 74 dollars goes to the workers in supply industries such as lumber yards, saw mills, mines, and quarries; to men engaged directly on the job, such as carpenters, painters, and electricians; to employes in offices of architects, engineers, and other professions profiting from building activities; and to workers for such transportation agencies as railroads and boats.

Most of these people earn comparatively small incomes, and they usually spend their money as they get it, paying it to grocers, butchers, clothiers, doctors, and so on. That is, practically three-quarters of the millions, the billions of dollars which America must pay out to catch up on its housing, will go into immediate and continuous circulation.

THE money experts have discovered that wage money travels from pocket to pocket so fast that in one week one dollar pays four dollars' worth of bills. For example: A dollar is paid to a carpenter, who uses it to settle a bill with his grocer, who hands it in wages to his delivery boy, who puts it into a payment to a jeweler for a ring for his sweetheart—all within a week.

We, of the Housing Administration, confidently expect that by December 31, 1935, America will have spent at least 1,500,000,000 dollars on modernization and repair. Add that to the three billions which, we believe with equal confidence, will be spent within the next year or so in new home construction; and we have 4,500,000,000 dollars going to the builders, building supply dealers, and others. Furthermore, there will be another tremendous sum that home owners and industrialists will pay out for new furnishings and equipment for their modernized and new buildings.

And three quarters of all those sums go at once into circulation and continue to circulate. It is now plain, I think, that I did not exaggerate when I said that builders, durable goods industries, and business generally had never before been offered the opportunity to develop so immense and so varied a market.



Loans will cover any permanent improvement such as re-decorating or building of book shelves and cupboards

Bear in mind that the National Housing Act, through the Better Housing Program, is the cause and source of that opportunity. The Housing Program opens the way for business to profit by its unprecedented opportunity. Through nation-wide educational work and the community campaigns, it tells the citizen how he can borrow money for repair and building; it tells the lending institutions that the Housing Administration will insure them against loss from such loans; and it tells the builder how he can finance construction of groups of buildings.

As directed by the Act, we have developed the Better Housing Program in two distinct sections: first, modernization and repair; second, new construction. We have appointed Regional Directors and State Directors and their Assistant Directors. We have other men in the field. The duty of them all is to co-operate with, and support, the Community Better Housing Committees.

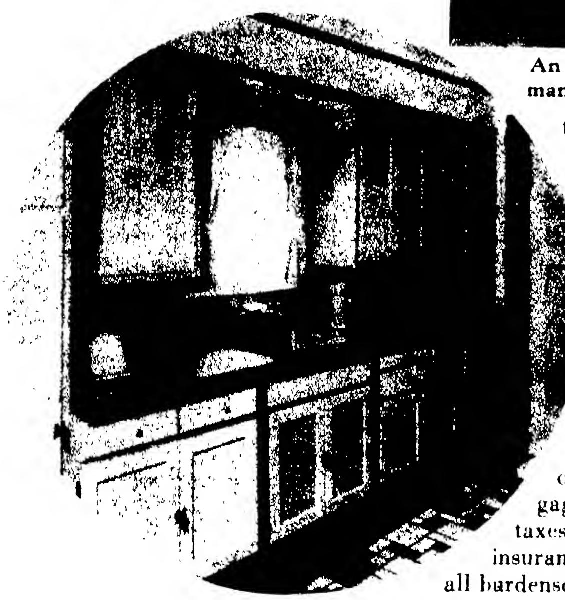
The community is the unit of effort and accomplishment under the Housing Act. The Federal Housing Administration is not authorized to repair or build. It has no money to give away. The American people are doing the modernizing and building, and they are paying for the work with their own money. They do it all through their community organizations. And right here let me say: They are making a fine job of it.

Under our Modernization Credit Plan in the Better Housing Program, the owner of a home or business property may borrow up to 2000 dollars to modernize, repair, alter, or otherwise improve his building.

He gets the money from a local lending institution which has contracted for us to insure its loans. He needs no other

signature or endorsement on his note than his own—except that, if he is married, his wife's name goes on his paper. The only requirements he has to meet are that he shall have a reputation for reliability, and an income or job which will enable him to repay the loan in monthly instalments over a period of three years or, in special cases, five years. Farmers may repay at longer intervals, since their earnings are seasonal.

With the money thus secured as a "character loan," the property owner can put on his land any sort of improvement that is permanent or "built in" (a burglar alarm or a front porch or even landscaping of the grounds around his home is permanent: a radio or a bookcase that is not built in does not meet the requirements).



An authentic "before and after" kitchen. Another striking example of permanent improvements that are permissible under the rules for FHA loans

The second section of the Better Housing Program is a long-range plan for the construction of new homes and the refinancing of mortgaged homes. It has been worked out under the Housing Act as the best conceivable means of accomplishing two things absolutely essential to the nation's recovery and permanent prosperity: First, revival of the at present dead mortgage market by adoption of a standard form of home mortgage throughout the country, and 100 percent mutual insurance of the mortgages under supervision of the Federal Housing Administration; and second, as a result of all that, the nation's catching up on its home shortage and thereafter continuing the steady rate of building required by a country as large and populous as ours.

THE whole new home construction part of our Program is based on the new form of mortgage and the rules governing its insurance. The new mortgage is given on 80 percent, or less, of the appraised value of the property—that is, the house and the lot. The mortgage can be for any amount and on a house of any value, so long as the mortgage itself does not exceed 16,000 dollars. It must be paid off in not more than 20 years by regular equal monthly payments on both the principal and interest. Also there must be regular monthly payments on such items as the mortgage insurance premiums, the taxes on the property, and the fire insurance, the total being not at all burdensome.

To enable financial institutions and other holders of mortgages to turn the insured mortgages into ready cash whenever they wish, national mortgage associations, under the supervision of the Housing Administration, will be established to deal in them.

If a man wants to build a new home and finance it with a mortgage, he submits complete plans and specifications of the structure to an approved lending institution which, in turn, submits them to a local representative of the Housing Administration. When the plans are approved by the Housing Administration, it gives in writing an agreement to insure the mortgage on his house, when completed. With the Housing Administration's agreement as security, he gets from a lending institution a construction loan. Upon completion of the house, he signs his mortgage and pays off the construction loan with the proceeds.

These hastily drawn pictures of the methods by which we make money promptly available for new building and for repairing of old structures are sufficient, I believe, to give a clear indication of how convenient and practical it is for the people to do the work, and how at the same time we insure financial institutions against loss from advancing the money needed for that type of work.

I am often asked, in letters and by visitors to my office: "How can the private citizen help to make the Better Housing Program 100 percent successful?"

My answer invariably is: "By working with the Better Housing Committee in your community; and if your town has not yet organized its committee, by doing everything you can to speed its formation. Tie in your business advertising with Better Housing. Help to put over the house-to-house canvass which in any and every community is the only way to produce the greatest possible amount of modernization, repairing, and building. And, above all, modernize and repair your own home and business property, and see to it that your office or plant equipment is brought up to date."

THEN, too, there is the Los Angeles Plan. That city and the state of California as a whole are going great guns in their modernization work.

One morning in Los Angeles I picked up a newspaper to see a full-page advertisement announcing that 100 of the leading citizens pledged themselves and invited others to join them, to undertake and get started 100,000,000 dollars' worth of modernization and new construction in their city.

There is no reason why any city or town in this country should fail to do the same thing—in proportion, of course, to its population and resources. If all the communities go in for such a schedule, there will be employment for every man and woman in America within 60 days.

In some states already, as a result of the Modernization Campaigns, towns have reported that all their building mechanics have jobs and they are sending to other places for more workers.

THE NEWER TELESCOPES

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

EVERYONE who has used a camera knows that a good lens should meet severe conditions. It must bring the rays to a *sharp focus*, not only at the center of the image, but over a *wide field* of view. It must bring light of all colors to the same focus—that is, it must be *achromatic;* and it is very desirable, though not necessary for all purposes, that it should give a bright image, permitting short exposure—it must be *fast.*

We all know, too, that to get an achromatic image even approximately, our objective must be made of two component lenses of different kinds of glass. To get a sharp focus over a wide field there must be three or four components in the objective, instead of two. Finally, a fast lens must be of large diameter compared with its focal length.

To meet all the conditions, which have here been merely outlined, demands the highest skill of the designer and the optician, so that good lenses are necessarily costly, even in the small sizes used in ordinary cameras. For the larger apertures used in astronomical work there is added the great difficulty of casting perfectly flawless disks of glass.

Some of these difficulties may be altogether removed and others greatly diminished by using mirrors instead of lenses. A reflecting telescope is perfectly achromatic, and the ratio of its aperture to its focal length can be made much larger than is practicable for a two-component lens. Moreover, by figuring the surface to an exact paraboloid of revolution, all the light of a star may be brought to a geometrically exact focus—barring the inevitable effects of the diffraction of light waves, which are alike in all instruments of a given aperture.

DESPITE these important advantages, the reflector has one very grave disadvantage. Its field of good definition is severely limited. The condition that all the parallel rays of a beam of starlight shall be brought by reflection to a sharp focus fixes the *form* of the mirror surface completely. It may be obtained by rotating a parabola about its axis. The only freedom left the designer is to determine the size of this parabola—that is, the focal length of his mirror—and of course to decide how large a portion of the infinite geometrical surface shall be arbitrarily brought into being upon his glass disk. But this paraboloidal surface will perform ideally well only when the stars' rays come to it along the direction of its own axis. If they are inclined to this at even a small angle, the rays reflected from different portions of the mirror will not converge to the same point. Those from the outer zone do not come to a focus at the same distance from the mirror as those from a zone near the middle of

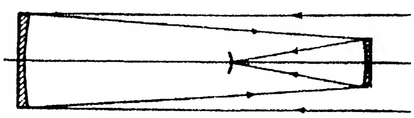


FIG.1

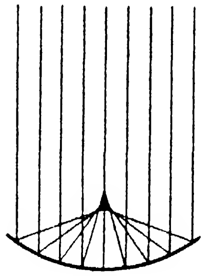


FIG.2

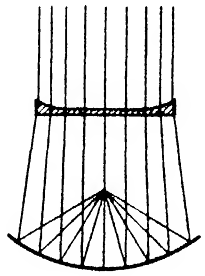


FIG.3

the mirror and their best approximation to a focus is displaced laterally away from the center of the field, so that the image becomes a roughly triangular mass like a half-opened umbrella or a tiny comet with a wide, bright tail.

This "aberration" of the image is called coma. It is always present, theoretically, except at the very center of the field. Its amount increases proportionally to the distance of the star from the center, and also to the square of the ratio of the diameter of the mirror to its focal length. The brightness of the image of any extended object, such as a nebula, is proportional to this last quantity. It is therefore impossible, with a single reflecting surface, to secure a bright image and a wide field at the same time. The star images go bad quite near the center.

With an aperture one fifth of the focal length, as in the 100-inch telescope at Mount Wilson, the deterioration of the images becomes perceptible to a trained observer at 3′.6 from the center, so that the field of really satisfactory definition is only one eighth of a degree in diameter. The 200-inch telescope will have to be made shorter in proportion to its diameter, to avoid enormously increased cost, and Dr. Ross calculates that the images will be really sharp in a portion of the plate less than one inch in diameter. It may be repeated that this property of the simple reflecting telescope arises from simple, though not quite elementary, considerations of geometry. It is incurable—unless we decide to make our telescopes more complicated in design. Then there are many ways of escape. By using two mirrors which divide the image-forming work between them, additional degrees of freedom become available and coma may be eliminated over a wide field.

THE first such scheme worked out in detail was by Schwartzschild, the most distinguished German astronomer of all times, in 1905. It employs a main mirror of small concavity, with a second more concave and of half the diameter placed in front of it (Figure 1). This gives a flat field, with good images over a region two degrees or more in diameter, and has great light-power, since the effective focal length, as determined by the scale of the image, is three times the diameter of the large mirror. But the tube from one mirror to the other is 25 percent longer than for an ordinary reflector. The loss of one quarter of the light by interposition of the second mirror is not very serious.

A reflector of this type is under construction for the University of Indiana. A second type, in which the small mirror is convex, 30 percent the size of the big one, and much nearer to it, was designed by the French astronomer Chrétien. A 40-inch telescope of this design has been constructed for the United States Naval Observatory by Mr. G. W. Ritchey.

It is also possible greatly to increase the available field of a parabolic mirror by interposing a specially constructed lens not far in front of the focal plane. The very complicated theory necessary for the design of such "correctors" has been developed by Dr. F. E. Ross, and lenses of this sort have been adapted to the 60-inch and 100-inch reflectors at Mount Wilson with great success, and will be provided for the 80-inch in Texas

and for the 200-inch in California.

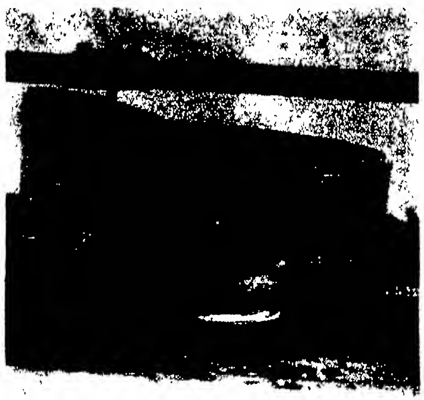
These devices, while of high value for use with large telescopes, do not permit the construction of mirrors with as favorable a speed-ratio as can be attained by the best lenses. A ratio of *f*/3.3 (that is, a focal length 3.3 times the aperture) is about the best that has been attained, while specially designed lenses have gone almost to *f*/1.0. Such image-forming systems of short focus and great speed are especially important for astronomical spectographs. The collimation of such an instrument—a small reversed telescope which receives the diverging beam of light after its passage through the slit and turns it into a parallel beam so that it may pass through the prisms without distortion—has perforce to be designed with the same ratio of aperture to focal length as the telescope which feeds it. (Even with the reflectors this is small, for the spectographs are used with a secondary concave mirror which lengthens the focus.) When there is plenty of light a long camera behind the prisms gives a large image full of rich detail. But, for faint objects and especially for extended surfaces such as nebulae, a short camera is necessary. This increases the intensity of the image by diminishing both its length and its breadth. Moreover, the spectral lines of the plate, being reduced images of the slit, are very narrow, and the slit may be widened, admitting more light without fuzzing up the negative perceptibly.

It was by inventing this short camera that V. M. Slipher at the Lowell Observatory succeeded, with a telescope of moderate size, in obtaining the first good, detailed spectrograms of the spiral nebulae, and so began one of the most striking advances of modern astronomy.

Now short focus lenses up to an inch or so in aperture can be perfectly well made, though it is skilled work. But a lens six inches in aperture and of similar shape would be so thick that much light would be lost in passing through the glass, and would be extremely costly to make.

A most ingenious solution of the problem has recently been made by Dr. B. Schmidt of Bergedorf, in Germany. The "Schmidt camera" uses a mirror instead of a lens, and returns to a very old practice by making its mirror spherical. Now every telescope maker—amateur or professional—knows that a spherical mirror is much easier to make than a paraboloid—indeed most mirrors are originally made spherical and then parabolized by gradually polishing away the excess material. But a spherical mirror, as all workers know, gives a most unsatisfactory image. The rays reflected near the edge cross nearer to the mirror than those which come nearer the center, and no sharp image can be secured, as is shown in Figure 2 (where the effect has purposely been exaggerated by taking the diameter more than twice the focal length).

This effect may be eliminated by changing the mirror to a paraboloid, but only at the price of introducing coma and narrowing the field of good definition. In place of this, Schmidt introduces a "correcting plate"—really a very thin, concave lens in front of the mirror.



While Professor Russell was writing his article, Harold A. Lower, an amateur of San Diego, unbeknown to him, was polishing the primary mirror of a Schmidt telescope camera, pictured above. The diameter of the Pyrex disk is 12 inches, its focal length 8 inches. Note, however, that this does not make the focal ratio *f*/.66, as might be assumed, since the aperture is four inches smaller than the diameter of the primary. The focal ratio is actually *f*/1. Its nickname is "The Soup Bowl." While the actual grinding and polishing of a mirror having so deep a curve as this presents no great difficulties, the testing is extremely laborious because the shadows are an unsafe guide for estimating the sweep of the curve; hence many narrow zones must be individually measured. Furthermore, putting the fine transition curve on the corrector lens, near the edge, is a job fit to tax the skill of a genius. The projected supplementary volume to "Amateur Telescope Making" will explain how to design one, but they are poorly adaptable for conversion to visual purposes

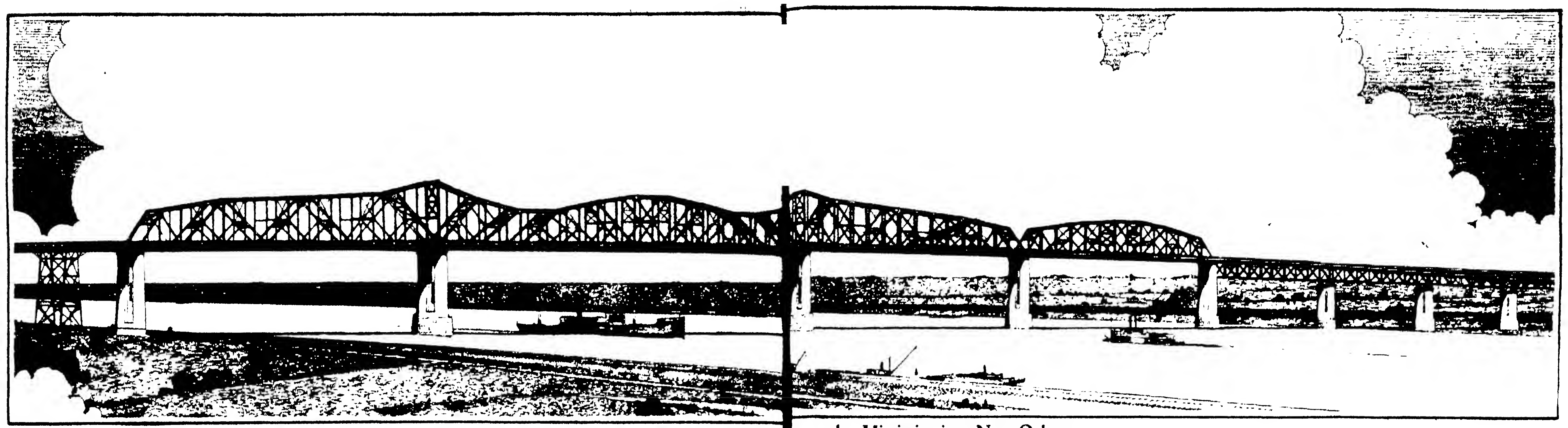
Its action is obvious from Figure 3. The rays near the center are very little deviated, while those passing near the edge are bent outward, and these strike the mirror at such angles that all are reflected exactly toward the same focus.

Even for the enormously exaggerated case shown in the picture, the plate is thin in comparison with its diameter, and its surface is considerably curved only near the edges. In practical application the curvature of the surface is so small that it is only perceptible by optical testing. A plate 12 inches in diameter, for example, will have surfaces which are never more than a thousandth of an inch removed from planes. After it has been carefully figured to its proper shape one would take it for an ordinary piece of parallel-faced glass—unless, indeed, one applied the severe test of looking through it at a very oblique angle.

With such a correcting plate the central image of a star becomes substantially as good as with a parabolic mirror. (Theoretically there is a slight departure from achromatism, due to the dispersion of the glass, but this is usually negligible in practice.) But the great advantage of this device is that the images of objects several degrees from the axis are almost as good as those at the center of the field. The spherical mirror itself produces no coma—only spherical aberration, and this to exactly the same amount no matter whether the rays fall on it from one direction or from another, for all parts of a sphere are alike. Inclined rays differ from axial rays only in passing through the plate at an angle. Now the whole effect of the plate is to introduce a distortion into the beam of rays, just sufficient, when they traverse it squarely, to undo the spherical aberration of the mirror. Rays traversing the plate at a moderately oblique angle will suffer very slightly greater deviations, the effect being a minimum for perpendicular incidence. As the deviations are small anyway, this change will be almost imperceptible, and the effect will be almost perfectly adapted to neutralize the aberrations of the mirror. In consequence, the images are good over a remarkably wide area. Mr. Schmidt has obtained photographs having a workable field 12 degrees in diameter.

A SERIES of Schmidt cameras is under construction for the large spectograph at Mount Wilson. By careful calculation of the curve of the correcting plate, an extraordinarily high speed-ratio can be secured. A camera with ratio *f*/1 is already in successful use, and one of *f*/0.57 is under construction, with an aperture 1¾ times the focal length! This should be of extreme value in observing faint stars.

At present this new device is likely to be of more service to the professional than to the amateur. The cross-section of the correcting plate is a curve of the fourth order, which must be calculated by the maker, and the figuring of the surface demands a rather unusual type of work. Moreover, the final focal image is not flat, but upon a spherical surface of radius equal to the focal length, so that special curved films would be required to cover a wide field. The very novelty of these problems, however, may be a challenge to the student who has already mastered the simpler technique of the ordinary mirror.—*Princeton University Observatory, April 5, 1935.*



Drawing of the railroad and highway bridge over the Mississippi at New Orleans

BRIDGING THE MISSISSIPPI

By HARRY J. ENGEL

THE city of New Orleans, one of the principal ports of the South, is served by various trunk line railways on both the east and west sides of the river. Traffic is carried over the river and into New Orleans by ferry crossings. The port has been extensively developed on the east side by the city of New Orleans, but interruptions to ferry traffic, as well as the expense and hazards of its operation, have been a serious handicap to commerce.

For those reasons, a railroad crossing or a combined railroad and highway crossing of the Mississippi has been under consideration in various forms during the last half century, the projects including low level movable bridges, tunnels, and high level structures similar in type to the bridge now under construction. In 1892, a bridge was designed for the Southern Pacific Railroad, and bids were received on it, but due to a business depression it was never built. Tunnels were judged uneconomical because of depth of water and other physical conditions. The idea of a bridge persisted, sponsored principally by the Public Belt Railroad, which provides terminal facilities and freight connections for all the railroads entering New Orleans.

In 1924, the Public Belt Railroad presented to the Board of Army Engineers representing the War Department their plans for a low level bridge with a vertical lift span for the passage of large ships. This design met with such serious objections from navigation interests, who contended that it offered an obstruction to shipping on the river, that the War Department rejected these plans. It was at this point that Ralph Modjeski was engaged by the Public Belt Railroad as chief engineer on their project, to consult with the Army engineers and to prepare final plans for the structure.

The site of this bridge and of all structures proposed by these interests is at a point on a straight stretch of the river about eight miles above the center of the city. The river circles around the city in a general west to east direction, so that the site is actually to the west of New Orleans. This point is particularly convenient for rail connections. Highway traffic reaches the bridge by way of Jefferson Highway, a principal traffic artery running up the river on the New Orleans side. The fact that it is a combined railroad and highway structure differentiates it from other recent bridge projects at the city, these others having been for highway traffic.

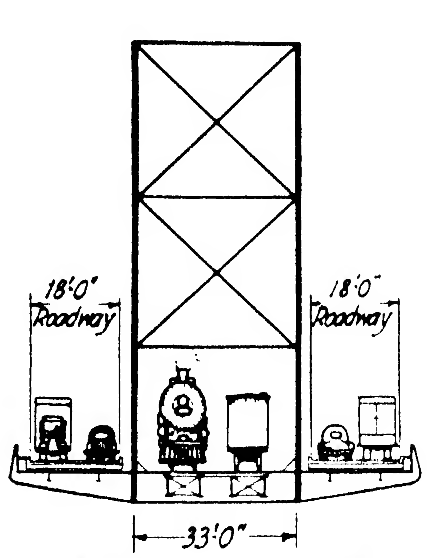
Deep water navigation continues up the Mississippi as far as Baton Rouge, above which only 65 feet of vertical clearance over high water is required by the War Department; but at New Orleans the requirement is 135 feet, equivalent to the clearance under Brooklyn Bridge. Although a permit was issued in 1925 for a high level bridge with only 112 feet vertical clearance over mean high water, the lapse of Congressional authority to build the bridge necessitated the securing of a new permit, for which the 135-foot requirement was stipulated.

THE final design of the bridge provides this vertical clearance above average high water, which is 18 feet above mean gulf level. The length required for the approaches is determined by this height, and by the railroad grade of 1.25 percent. High water of the river on the lower Mississippi is well above normal ground level, requiring further increase in the length of these approaches. The New Orleans Bridge is, therefore, one of the longest important bridges in the world, with a total length of steel structure of 22,995 feet, or almost 4½ miles.

Two railroad tracks are provided on the structure, and two 18-foot roadways with sidewalks are cantilevered outside the main trusses. On the approaches, the highways descend on a 4 percent grade outside the railroad structure, and because of their steeper grade, reach ground level before the railroad deck.

For horizontal navigation clearance, the War Department required a principal span of 790 feet, which is made the cantilever span of the main bridge. The anchor arms are each 530 feet long. A through truss span on the New Orleans side of the cantilever is similar in appearance to the suspended span. Four deck spans, one of 330-foot length and three of 267-foot length, complete the main bridge superstructure. The approaches are of steel trestle type, on wooden pile foundations.

Pier four under construction, showing the special tower derrick used for placing concrete on top of pier. Masonry facing on lower part of pier can also be seen



Arrangement of railroad tracks, roadways, sidewalks on the bridge

The foundations under the main bridge provide one of the most interesting features of the work. The depth of the river here is as much as 75 feet below gulf level at the site of one of the piers. The river bottom is composed of alternate layers of sand, silt, clay, or mixtures of these materials, all of which are delta deposits of the Mississippi River. Using Professor Terzaghi's principles of soil mechanics, studies were made on samples of the materials brought up by the borings, and these studies revealed that the larger piers would reach a stable condition if carried to 170 feet below gulf level, resting finally in compact sand.

This considerable depth made desirable the use of open dredging well caissons for the foundations. This type of caisson has been used for the deepest bridge foundations on record. Consisting only of vertical cellular walls of steel, timber, concrete, or combinations of these materials, the bottom having a metal cutting edge, only skin friction limits the depth to which this type can be sunk. Since there is no working chamber under compressed air, the limit of about 110 feet in pneumatic caissons, fixed by the hazard of caisson-disease, is surpassed. As a general type, the open dredged caisson has, therefore, been recognized as most suitable for the deepest bridge foundations, and by 1915 had already been carried to a depth of 160 feet below low water in the piers of the Hardinge Bridge across the lower Ganges, and to a comparable depth in a bridge over the Atchafalaya River at Morgan City, Louisiana. More recently it was used with only slight modification in the foundations of a new bridge at Morgan City, where it was carried to a depth of 176.5 feet below water level; but here conditions were less hazardous than at New Orleans.

In the preparation of the New Orleans plans, open dredged caissons of the conventional type were designed for pier construction.

When bids were called for on these plans, conceived around the idea of the conventional method of sinking such open dredged caissons (which method depends largely on caisson weight to ensure even sinking), Siems-Helmers, Inc., who were bidding, proposed to use the sand island method of sinking, to ensure stability during the entire operation.

This sand island method is not new. Rather, there are historic examples of its use in Asia; but the revival of its use for important foundations has been only recent, dating from the construction of the foundations for the Suisun Bay Bridge of the Southern Pacific Railroad to California in 1929. The method consists of first building a cylindrical artificial island of sand to above the water level, thus creating artificial ground on which all future work can be carried out, the caisson being built in place on this island and sunk through it by stages.

WORK is begun at the pier site by sinking woven willow mattresses under a burden of rip-rap to the river bottom at the planned location of the pier. Following this, a circular ring of falsework piles is driven around the outline of the sand island. Within these piles large metal rings of more than a hundred feet in diameter are sunk one above the other by means of hoist frames mounted on the piles. Inside this built-up metal shell, which rests on the river bottom and rises to above high water level, sand is filled, also to above high water level.

The metal cutting edge is assembled and riveted together in the correct plan position on the top of this island, and removable forms are placed for the first lift of the reinforced concrete caisson walls above this. This lift, and all subsequent ones, are placed above water level, in the dry where they can be easily inspected. The concrete caisson walls thus built make up the outer shell and also outline the dredging wells. With the completion of the first lift, of say 20 feet height, excavation is carried on through the wells, and the caisson sinks under its own weight. When the top of this first lift has been lowered by the sinking to the elevation of the top of the sand island, work is begun on the next lift, and so on until the caisson has reached its planned depth. Then the seal course is placed with either bottom

Erecting steel for the superstructure of the main bridge. The quick incline down from extreme left is the roadway; the gradual incline is the railroad

dump buckets or tremie, and the caisson can be unwatered for future work if filling with concrete is intended; or left filled with water if it is only to be decked over as it is at New Orleans. The fact that all these operations take place within the artificial island of sand suggests the high degree of stability of the caisson during the entire process of sinking. Moreover, the extreme variation of river height during spring floods and subsequent low water can have no effect on the work, since the height of the artificial ground provided by the island is above these influences.

ACTUAL construction on the foundations of the New Orleans Bridge was begun early in 1933. The sand island method of caisson sinking has been since successfully applied to all of the river piers, numbered I to V. The remaining piers B, C, and D under the main bridge on the New Orleans side of the river are founded on piles, and the single main bridge pier A behind the levee on the other side of the river was founded in an open-dredged caisson sunk by the conventional method.

In the use of the sand island method at New Orleans, natural conditions created difficulties which had not been met before, but they were successfully overcome, and the last of the river piers was sealed during August, 1934. These difficulties were caused by the tendency of the foundation material to blow into the caisson during dredging. As a rule, it was found necessary to keep the weight of the concrete caisson as great as possible in order to follow closely the dredging operations, and to dredge out some of the overburden of sand in the outlying island in order to prevent a pressure blow-in of river sand from the outside. In the instances where such blows occurred, however, no lives were lost nor was any valuable equipment destroyed. All caissons were finally sunk accurately to their planned position and sealed in good sand.

After each caisson had been sealed with a tremie, the water in the timber cofferdam above the caisson top was pumped down to elevation - 35. This was done to permit the pouring of the distributing block, and the decking over of the wells outside the distributing block in order to prevent the wells from gradually filling with silt borne down the river by the current. Since this unwatering placed a hydrostatic head on the seal, it offered a good test of the soundness of the concrete, in each case demonstrating that the seal was tight.

SOME of the details of operation on this completed river work are of interest. After the preliminary ring of falsework piles had been driven through the mattress at the site of a pier operation, 12 hoist frames were mounted on the circular platform provided above it, in order to lower the rings which constituted the steel shell periphery of the sand island. The diameters of the steel shells varied from 111 feet to 121 feet. In general, the steel rings were 10 feet high, those at the very bottom being only 5 feet and 2½ feet to reduce loss in case they could not afterward be salvaged. They were assembled in place, three 10-foot sections at a time, resting on needle beams spanning the false-work, and lowered from this position with the hoist frames. When a section had been lowered, the shell weight was again transferred to needle beams and another section assembled above it. Thus the shell was built up gradually, always supported from the top, until it rested on the mattress. The mattress was then cut through, the part inside the shell removed, and the sand island fill placed as explained above.

The sand for filling the islands was obtained by pumping sand off the river bottom with a high pressure pumping barge originally intended to be used when necessary to jet away obstructions to the caisson during sinking. Jetting was never actually found necessary during the work.

The floating concrete plant used on the river work contained two two-yard mixers, capable of producing 120 cubic yards of concrete an hour. This plant was fitted with the most modern mechanisms for weighing, batching, and measuring the materials, and produced excellent concrete. River water was used for mixing.

The river piers extend 145 feet above low water, the lower portions being faced with granite for protection against water action. To place concrete at the tops of the piers, a special tower derrick was built, consisting of two barges framed together, supporting a structural steel tower 100 feet high, having on top a stiff-leg derrick, and equipped with a hoisting engine and boiler plant.

BY the close of 1934, all substructure work had been completed, as well as the superstructure of both approaches. Only the superstructure of the main bridge remains to be completed, and this is in process of construction. This work on the main bridge steelwork began about the middle of March, 1934.

The main bridge superstructure is being erected by the balanced cantilever guy-derrick erection method. An adjustable erection bent is placed near pier I, and another near pier II, permitting steel to be erected in both directions from each of those two principal piers. The derricks move forward on skids on the stringers of the railway floor, erecting truss members ahead of them and turning around to fill in the other members behind them. On the cantilever, work proceeded inward from piers I and II toward the centerline of the suspended span. The two halves were joined on meeting in the center.

The bridge is owned jointly by the State of Louisiana, and by the City of New Orleans acting through the Public Belt Railroad Commission.

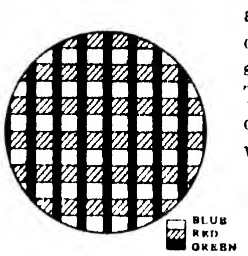
Contractors for the main bridge foundations were Siems-Helmers, Inc.; for the approach foundations, MacDonald Engineering Corporation; for the main bridge superstructure, American Bridge Company; for the approach superstructure, the McClintic-Marshall Corporation.

Modjeski, Masters and Case, Inc., of New York, Philadelphia, and Harrisburg, are the designing and supervising Engineers. Moran and Proctor were the Consultants of the Engineers on the main bridge foundations. C. Glennon Melville is the Engineer of Construction for Modjeski, Masters and Case, Inc.

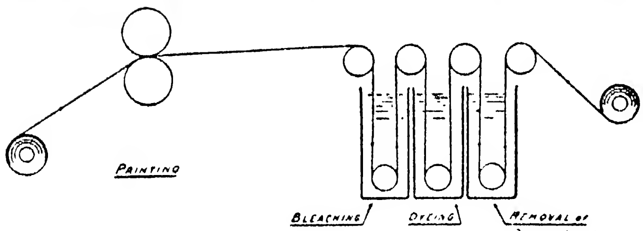
Color Photography
For the Amateur

Dufaycolor . . . Uses Fine Three-Color Screen . . . Needs No Special Equipment

AMATEUR motion-picture film that photographs scenes in natural color, announced in the Scientific American Digest last month, has now been available to serious-minded photographers in the United States for several weeks. and has been giving excellent results. This film, known as Dufaycolor, may be used in any camera without expensive accessories, and may be shown with any projector. Another desirable feature is that, while the film which the photographer exposes in his camera is reversed in processing to give a positive for projection, any number of additional positives may be made by special equipment to be available soon. The color effect is obtained by the use of a three-color screen or "réseau" which is mechanically printed on one side of the film, and a special panchromatic emulsion over the réseau. Contrary to conventional practice, the film is loaded in the camera with the emulsion side away from the lens. Thus the light passes first through the film base, then through the réseau, and finally onto the emulsion.



***Left:* The three-color réseau of Dufaycolor film, magnified. *Below:* Diagram shows printing, bleaching, and dyeing**



In the preparation of this film, the stock is processed by a highly accurate printing machine and a series of dye and bleaching baths, shown diagrammatically above. By applying first a dye, then a series of greasy, moisture-resisting lines, and bleaching the uncovered areas, and repeating these steps until the three-color screen is completed, the film stock is completely covered with a color réseau in which the edges of each dot (see small illustration above) are accurately aligned with those adjacent to it, yet there is no overlapping of colors, nor is there any space between the dots. Much of the success of this film is due to the design of the machinery used in processing; the screen system of color photography is not new, but by refined methods of production is now commercially practical for amateur or professional use.

It is obvious that with this screen on the film stock, all light reaching the emulsion will first pass through the screen and be filtered into its various components. The dots of the screen are each approximately 1/500 of an inch square and act both as filters for exposure and as a means of "putting the color back" in projection. The film is available for 16- and 35-millimeter work, and in the latter size is furnished for miniature cameras. Speed of the film is one half of standard black and white film.—*A. P. Peck.*

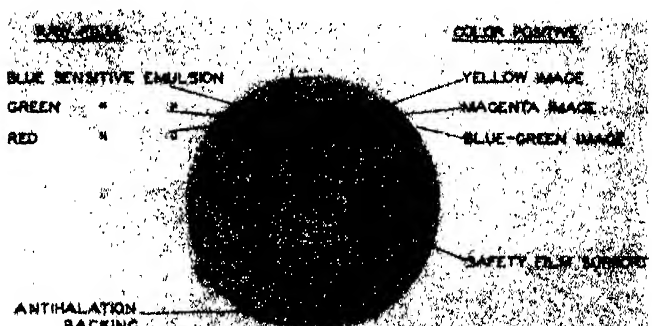
Kodachrome . . . Self-Contained Screenless Filters . . . Simplicity a Feature

ABOUT five years ago when Kodacolor was announced by Eastman, this remarkable advance in colored movies for the amateur was considered to be very nearly the ideal. With this process, however, it was necessary to use on the camera a special multiple color filter, and in projection a similar filter had to be used. In addition, the film itself had embossed upon it tiny lengthwise lenses so that the final projected picture had a linear "grain" which was objectionable. Thus Kodacolor did not follow the principle of simplicity laid down in the early days by Mr. Eastman.

For 16-millimeter motion pictures, this basic principle has now been attained in full through Kodachrome, just announced by the same company. This new film can be used in an ordinary 16-millimeter camera with no extra equipment and no adjustment except use of next larger stop. The finished film when projected shows true colors and tones without any sort of grain.

In the Kodachrome process, the film is coated five times, as shown in the accompanying diagram. Nearest the base there is a strongly red-sensitive emulsion. Over this is an extremely thin separating layer of gelatin containing some dye which acts as a filter. Above this is a green-sensitive emulsion followed by another separating layer. Finally, the top coat is blue-sensitive. Light from photographed objects is separated into its color components by the various coatings, the blue-green image being formed in the red-sensitive emulsion nearest the base, the magenta image in the middle layer, and the yellow in the top.

Processing of films will be done in Rochester until enough complicated processing machines can be built for it to be done at other strategic points. At the present time, the film is available only in 16-millimeter size but will probably be available later in 35 millimeter. No arrangement has been made to produce duplicates but no doubt this problem will soon be solved by the Eastman laboratories.



Cross-section of Kodachrome film, showing emulsions

Kodachrome is the invention of Leopold Mannes and Leo Godowsky, Jr., both of whom are well-known in the musical world. Their original conception was brought to fruition in collaboration with and under the able guidance of Dr. C. E. K. Mees, to whom much credit is due for this outstanding development.—*F. D. McHugh.*

HEAVY WATER

A New Hydrogen and a New Water . . . Chemical and Physical Properties Distinctly Different From those of Plain Hydrogen and Plain Water

By HAROLD C. UREY, Ph.D.
Professor of Chemistry, Columbia University

THE discovery of the isotope of hydrogen, the so-called "heavy hydrogen" or deuterium, and its successful separation from the light variety, has excited great interest in scientific circles. In order to understand this interest, it is necessary to review briefly some of the important rôles which hydrogen plays in the sciences of chemistry, physics, and biology.

Hydrogen is not the most abundant element on earth—that position goes to oxygen—but it is the one which is present in more chemical compounds than any other. Moreover, it is present in many of the objects which we meet in our scientific studies and every-day life.

Water consists of molecules, each of which contains one atom of oxygen and two of hydrogen, and being the most common liquid on the surface of the earth, is used most extensively in scientific work. A very large fraction of our chemical reactions which are studied in our scientific laboratories and used in industrial processes take place in the presence of water. On the other hand, since all living organisms live essentially in water, it is most important, from the standpoint of biology and in everyday life.

Moreover, the hydrogen atom is the simplest in its structure of all the atoms we know. It consists of but two particles, a heavy central positively charged particle, and a light negatively charged particle. Because of the simplicity of this atom, it has been possible to devise theories of its structure which can be checked exactly against the experimental properties, and this exact theory of the hydrogen atom has enabled us to understand in a less exact fashion the structure and properties of more complex atoms.

FOR these reasons, a new hydrogen, a new water, and all of the new chemical compounds containing hydrogen, make possible some very interesting studies in three of the major sciences. We have already secured a much better understanding of the details of chemical reactions involving hydrogen by using the heavy variety. Physicists also have made some very interesting experiments on the properties of heavy, positively charged particles of atoms, the so-called nuclei, by means of heavy hydrogen. Little has yet been done on the biological effects of heavy water, but such experiments also will probably be valuable in understanding more of living processes.

HOW important is heavy water likely to be in a practical way? The Science Advisory Board of the National Academy of Sciences and National Research Council, composed of K. T. Compton, Campbell, Bowman, Dunn, Jewett, Kettering, Leith, Merriam, and Millikan, makes the following pertinent comment in its Report: "A 'scoop' for American science was the discovery of the heavy isotope of hydrogen—hydrogen of twice the atomic weight of ordinary hydrogen. This opens up the possibility of forming an entire new group of hundreds of thousands of organic chemicals, with properties differing somewhat from those which are now known. This is a most interesting problem, whose technique is pretty well mapped out, which is of enormous extent, and which is practically certain to yield chemical compounds with valuable new properties—particularly in the field of drugs, medicines, and dyes." Thus heavy water will not be a laboratory plaything, and we venture the prediction that it will reach every reader's life in some practical way within five years. The article here presented is published in cooperation with the American Institute, New York organization of scientists.—*The Editor.*

Until about 1911, it was generally supposed that all of the atoms of each element were exactly identical. At that time we knew that they consisted of a positively charged heavy central nucleus and a number of electrons carrying negative charges moving in some fashion about this nucleus. It was assumed that the masses of these particles were the same for all atoms, and that the number of charges was the same. However, a study of radioactive elements showed that two varieties of atoms of a single element, differing only in mass from each other, the electrical charges throughout being the same for the two atoms, certainly existed, and it was found that two such atoms had precisely the same chemical properties. They formed compounds of the same kind, and it was impossible to separate these two atoms by the usual methods which are used in chemistry for the separation of elements. Two such atoms were referred to as isotopes.

Later, by deflecting charged atoms in electric and magnetic fields, Sir J. J. Thomson showed that the element neon consisted of two varieties of atoms, the one variety having a mass of 20 units and the other a mass of 22 units, using the mass of the oxygen atom as equal to 16 units. Following this, studies by Aston, using a similar method of investigation, have shown that a large number of our chemical elements consist of mixtures of atomic species differing in mass. The element tin consists of 11 such varieties; the element sodium has but one; and the element chlorine two, and so on. The methods which these men used were able to detect an isotope if it were present to the extent of about one percent of the total number of atoms.

ANOTHER method which has been used in recent years for the detection of isotopes is the method of molecular spectra. The wavelengths of light emitted by molecules depend upon the masses of two atoms in the molecule, and the theory is sufficiently well developed so that it was possible to predict exactly what the effect of mass on the spectrum should be. By the use of molecular spectra, oxygen was shown to consist of three isotopes having masses 16, 17, and 18; carbon of two, whose masses are 12 and 13; nitrogen of two, whose masses are 14 and 15. In this way it was possible to detect the presence of an isotope which constituted only about one part in 1000 of the total number of atoms.

Indications that there should be an isotope of hydrogen came from the de-

termination of mass of the hydrogen atom by two different methods. The one method depends upon the average mass of the two hydrogen atoms in their proportions in natural hydrogen, and the other determines the mass of the light one only. When reduced to the same standard of mass, these two results disagreed, and the difference, as pointed out by Birge and Menzel, could be understood if there were one part of a hydrogen atom of mass 2 in 4500 of hydrogen atoms of mass 1. This indicated that if the hydrogen isotope were present in natural hydrogen, it must be so rare that none of the methods used for its detection would be successful. Some other method of attack on the problem was necessary.

A THEORY of the solid state proposed many years ago by Debye made it possible for us to calculate the difference in boiling points of hydrogen and deuterium, and this calculation showed that their boiling points differed by appreciable amounts, and that they should be separable by distillation, much in the same way that water and alcohol are commonly separated.

A special method of detecting this isotope was required, for the deflection of charged atoms in magnetic and electric fields could not be used for the detection of the hydrogen isotope, since its abundance even in the prepared samples would be too low. The method of molecular spectra also could not be used, for the spectrum of hydrogen gas is particularly difficult to analyze. In 1913 Bohr showed that the wavelengths of light emitted by hydrogen atoms should depend on the masses of these atoms, and his theory gave a quantitative relation between these masses and these wavelengths so that this method could be used in the case of the hydrogen isotopes, though it cannot be used in the case of other atoms. The spectrum of hydrogen in the visible region consists of four wavelengths lying in the red, the blue-green, and two in the violet. Calculations using Bohr's theory showed that the wavelengths of the light emitted from the deuterium should be displayed toward the violet side of these lines by about 1.8, 1.3, 1.17, and 1.08 Angstroms for these four wavelengths respectively. We found that these wavelengths were present both in ordinary hydrogen and also in the concentrated sample, thus proving the existence of the heavy isotope.

The method of distillation of liquid hydrogen for separating the two isotopes of hydrogen would be a long and expensive process, and much of the interest in this problem has come as a result of the discovery by Dr. E. W. Washburn of the Bureau of Standards of the electrolytic method for separating the hydrogen isotopes. In the industrial production of hydrogen and oxygen for use in oxy-hydrogen blowtorches and other purposes, a large nickel cell is used, containing two electrodes which are separated from each other by an asbestos diaphragm. When the current flows through a potassium hydroxide solution in the cell, hydrogen is formed at the one electrode and oxygen at the other. The hydrogen gas which escapes from the cell contains about one-quarter to one-sixth as much deuterium as the water in the cell. As a result, the heavy isotope increases in concentration in the residual solution of the cell.

Professor Urey, who has just been awarded the Nobel Chemistry Prize for his discovery of heavy hydrogen

As a result of this, the liquor in these electrolytic cells contains about 1 part in 1200 of deuterium, so that the concentration of deuterium in perhaps 100, 000 gallons of water in this country is already as high as that which Dr. Brickwedde was able to produce by the distillation of hydrogen. By modifying this method, it is possible to prepare pure heavy water, which is now being done in quite a number of laboratories in this country and abroad. Professor G. N. Lewis of the University of California was the first to secure it in a highly concentrated form. The cost of this heavy water is now about 75,000 dollars a gallon.

In science, we are constantly attempting to rationalize our observations and experiments by means of theories, the theories being really only exact methods of describing the observed phenomena. Throughout all our chemical theories, the masses of the atoms play an important part. Our kinetic theory of gases, for example, states that the number of collisions between the molecules of a gas is inversely proportional to the square root of their masses; and the velocities with which chemical reactions proceed also depend upon the masses of the atoms concerned. Many other considerations enter into such theories, but this is always one important constant. Up to this year, we have never been able to determine directly whether the theory and experiment agree, for, if we worked with atoms of different elements, their characteristics changed in other ways in addition to the mass. Only with the separation of the two hydrogen isotopes were we able to attack this problem directly. We can now test the theories dealing with the velocities of chemical reactions, the thermodynamic properties of substances, and other similar phenomena by using the two varieties of hydrogen. The ratio of masses is conveniently large, so that comparatively large effects are to be expected.

Early in 1932, Dr. Rittenberg and I made some calculations on the equilibrium constants of certain chemical reactions involving hydrogen, chlorine, and iodine. Thus, if hydrogen iodide gas, whose molecules consist of one atom of hydrogen joined to one atom of iodine, is heated to 300 or 400 degrees, Centigrade, the gas partially dissociates into hydrogen gas and iodine gas, so that only about 20-25 percent of iodine remains in the form of hydrogen iodide. Our calculations show that the percent dissociation of hydrogen iodide should depend upon whether the light or the heavy hydrogen was used. The differences to be expected were rather small—of the order of magnitude of a few percent. During the past year, we have checked the predictions of the theory, and have secured exact agreement between them. Other examples have been observed. Thus we find that the chemical properties of the two hydrogens are different by measurable amounts, and in fact, they are so different that, had the two hydrogens been present in natural hydrogen in approximately equal amounts, the variation in the chemical properties of hydrogen could not possibly have been overlook and would have been evident from

beginnings of scientific chemistry.

The physical properties of the two hydrogens and their compounds are also distinctly different. First of all, the melting points of the two hydrogens differ by about 4.7 degrees, Centigrade, which is a very large percent change, for the melting points are 13.9 and 18.6 degrees above absolute zero. Moreover, the melting points of the light and heavy water differ by 3.8 degrees, Centigrade, and the boiling points by 1.4 degrees. Other physical properties differ for the two compounds of the light and heavy hydrogen respectively. The refractive indices, surface tension, melting points, boiling points, densities, viscosities, and so forth, may all be different. All these differences must be due just to the change in the mass of these atoms, and though none of them can be said to be clearly understood at the present time, the deuterium and its compounds enable us to make a much better attack on the problem.

DURING recent years, we have made extensive studies on the velocities of chemical reactions in water solutions, particularly, and also in the gaseous state. The theory of these reactions is in a fair state of development, but the effect of mass on such phenomena will certainly be clarified by a study of reactions in which deuterium and its compounds replace hydrogen and its compounds. For example, we have found that the velocity of reaction between the light water and aluminum carbide to form methane is about 23 times as great as the reaction between heavy water and aluminum carbide to give the heavy methane. This is really an enormous difference, and very easily measured. Such studies give us a grasp on reaction kinetics quite beyond our dreams of a few years ago.

The biological interest of the heavy water can hardly be overemphasized, since all living things live essentially in a water solution. Up to the present time, experiments, particularly by G. N. Lewis and H. S. Taylor and their co-workers, indicate that animals die when placed in deuterium of high concentration, though they are able to live in the 30 percent water. The evidence in regard to plants is more contradictory. Professor Lewis finds that tobacco seeds do not sprout in deuterium oxide, while Dr. Chessley and Dr. Suguira find that wheat seeds do sprout in such water. In other cases that have been investigated, certain fluorescent bacteria do not give out their fluorescent light in the presence of heavy water, while other varieties continue to emit light. It is my own expectation that both animals and plants can be acclimatized to high concentrations of heavy water, but that probably their living processes will be much slower.

The medicinal effects have often been mentioned, but mostly without adequate foundation. Experiments made on the effects of deuterium on cancer seem to indicate that there is little difference in the behavior of such tissue in the presence of either light or heavy water. The contribution which deuterium will make to medicine will be through a better understanding of the fundamentals of living processes rather than through its use as a medicine directly. By its use we can follow the course of food, for example, through the body. We feed the animal a food containing heavy hydrogen, and then watch for the heavy hydrogen in various parts of the body.

Courtesy Dr. W. G. Brown, Columbia University

Apparatus for obtaining heavy water by the electrolytic method described in the text

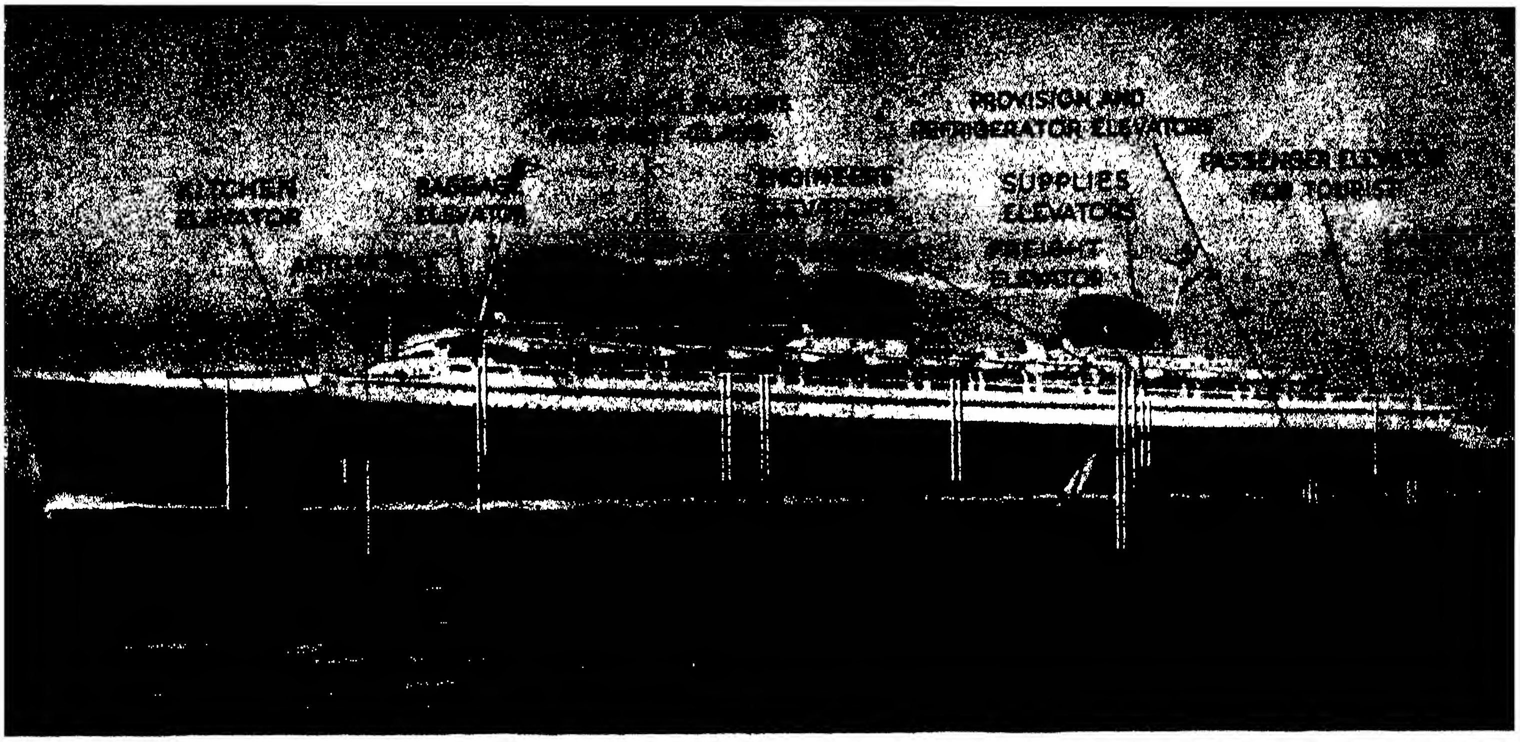
The nucleus of the deuterium atom is at present one of the most delightful playthings for physicists. In recent years, we have learned to transmute the elements one into another. This is accomplished by bombarding these atoms with very high speed particles, using the high-voltage machines which have been developed particularly by Lawrence, Lauritsen, Tuve and van der Graaff in this country, and by Rutherford and his associates in England. The particles which have been used in the past are the proton, which is the nucleus of the hydrogen atom, and the alpha-particle, which is the nucleus of the helium atom.

Recently, we have discovered the neutron, which is an uncharged particle of small dimensions having a mass nearly equal to that of the proton, and the deuteron or nucleus of the deuterium atom. The most intense source so far known for the neutrons is secured by bombarding beryllium with the deuterium nuclei.

As a result of such bombardment, lithium is converted by helium, and beryllium, boron, carbon and nitrogen are converted into other elements. One of the most interesting of these is that observed by Rutherford in England, and by Professor Ladenberg and his colleagues at Princeton. They bombarded deuterium atoms with the deuterium nucleus and succeeded in producing a hydrogen atom of atomic weight 1 and another hydrogen atom of atomic weight 3. This still heavier variety of hydrogen of atomic weight 3 has also been observed to be present in natural hydrogen to the extent of about 1 part in 10 billion. Its separation from the light hydrogen would involve an enormous expenditure of effort and if it could be separated, would cost millions of times the cost of the hydrogen of atomic weight 2. In these processes large amounts of energy are liberated in the individual process. The over-all consumption of energy is much greater than that produced, however.

One problem which challenges physicists particularly at the present time is the structure of the atomic nucleus. We understand fairly well the structure of the electronic atmosphere of atoms, that is, the outside structure, but the structure of this minute central sun of the atom is quite unknown at the present time. In unraveling this structure of the nucleus, the deuterium nucleus, or deuteron, will certainly play an important part. It is the simplest nucleus except the nucleus of the light hydrogen atom, and it is supposed at the present time that it consists of two particles. Just as the hydrogen atom enabled us to develop an exact theory for that atom, and to understand in a less exact fashion the structure of other atoms, so we may expect that the deuteron will enable us to make an exact theory for it, and a less exact one for other atomic nuclei.

I HAVE indicated some of the uses for heavy hydrogen. In the past the uses for it multiplied so rapidly in the hands of a host of research workers that I think it was quite impossible for any of us to foresee at the time of the discovery the many uses to which this atom could be put in research work. I think probably that the developments of the future will also be beyond the few indications which I have given.



Location and shaft lengths of the many different types of elevators aboard the *Normandie*

SEA-GOING ELEVATORS

World's Largest Liner Has 23 Elevators Especially Designed for Ocean Operation

THE new world's largest liner *Normandie,* which was built by the French Line and is now on her maiden voyage, is more than a great merchant vessel. She is a self-contained city with a potential population of 3500. This luxurious "city-structure" of 14 stories has, in addition to modern plumbing, lighting, telephones, radio broadcasting, fire and police systems, the most complete elevator service of any ship afloat. There are, to be exact, 23 elevators—for passengers and freight, for storerooms and kitchens, and even for motor cars which passengers may carry with them to Europe.

Elevators in buildings are comparatively simple because a building maintains a vertical position. At sea the elevator problem becomes more difficult because of the pitching and rolling of ships, and further because of constant exposure to the corrosive action of salt air.

Ship elevators, therefore, are designed especially for sea-going service. The automatic electric switches of those on the *Normandie* will not swing with the motion of the ship and thus operate elevators prematurely; the machinery will not spill oil; and the electric cables beneath cars are confined in a protective sheath to discourage any tendency to whip around equipment in the hoistway. Safety devices are provided on the cars for the protection of the passengers—and on the counterweight for the protection of the ship and those members of the crew who may be stationed below the elevator's lowest landing.

To combat corrosion, all elevator parts are treated in accordance with the most rigid shipboard practice. All exposed metal surfaces are painted with red lead, and electrical equipment is coated with a special water-resistant varnish. Vital operating parts of the safety devices are rust-proofed to allow free motion at all times, and lead and armored-cable construction is used for electric wiring. Eleven of the elevators are for passengers and 12 are used to carry provisions, baggage, laundry, and so on. Fifteen of the total were manufactured and installed by Ateliers Otis Pifre, the French affiliate of the Otis Elevator Company.

FIRST class passengers have seven elevators at their disposal, four of these having a capacity of 4000 pounds each, or approximately 25 persons and being automatic, self-leveling, Otis machines. By means of these, first class passengers may reach A, B, C, and D decks, the promenade deck on which are smoking rooms, theater, winter garden, staterooms, and so on, and the main deck on which there are shops, a library, and staterooms.

Tourist class passengers have a single elevator aft which serves their section of the ship from the promenade deck down to E deck. This section of the ship contains, besides cabins and dining room, a children's playroom, a covered promenade, and a room for mechanotherapy.

Third class passengers have a single passenger elevator aft, near the stern, which serves from B deck down to F deck. Engineers and machinists have two elevators; the laundry is served by three; and other ship services are supplied by elevators, built to their needs, as shown in the diagram above which was especially prepared for use with this article.

Of particular interest is the automobile elevator which is provided in the forward part of the ship to carry automobiles from E deck down to the hold of the ship. A passageway is provided in each side of the elevator on E deck so that automobiles may be driven aboard from either side. Entrance is gained through a large hatch which opens at the side of the ship. By means of a gangway or a special dock elevator, automobiles are conveyed from the dock to E deck. By this special arrangement automobiles may be driven aboard and will no longer be hoisted on board by cable as has been the custom in the past. This special elevator carries the automobiles down to decks H and G and the hold. A special turn-table feature is provided on this elevator which permits the automobile to be swung to an angle of 90 degrees before leaving the elevator. As the hold is narrow in the bow, this greatly facilitates the storing of the automobiles.

THE AMATEUR AND HIS MICROSCOPE—XVI

THRILLS FROM A HOME-MADE POLARIZER

By PHILIP R. TARR

(In Two Parts. Part 2)

As you will observe, when looking through the polarizing microscope described last month, the field becomes alternately light or dark for each consecutive 90 degrees as the analyzer is rotated. Except for the small amount of scattered light seen in the dark field position, and the slight, almost imperceptible distortion, the apparatus is as useful as one made of the more expensive Nicol prisms.

If you wish to improve the analyzer slightly, a better grade of glass may be obtained from a photographic manufacturer, in which case the grade of glass used for making photographic filters, known as "flat, optical glass," should be ordered. The price of this glass will be considerably higher than for ordinary lantern slide glass mentioned last month.

Adjust the analyzer for dark field and place upon the stage a thin piece of mica, such as may be obtained from a hardware store for use in oven door windows. The field immediately becomes light, and if the mica is of the proper thickness, beautiful colors are obtained, ranging from green or yellow to magenta. This color may be changed by rotating the analyzer.

If the color is not found to be present, the mica plate is probably too thick and a few layers should be removed. This may be done by splitting the edges with a small sharp needle, removing only a few plies at a time until the colors are obtained.

As a further experiment, bevel the edge of the mica plate with a sharp razor blade, so that the beveled portion is at least one-sixteenth inch wide. Examine this edge while rotating the analyzer. A multitude of beautiful colors will be seen, arranged in rainbow fashion but many times more brilliant than a rainbow and ever changing as the analyzer is turned.

After adjusting the mica plate so as to obtain colors, it should be bound with paper tape (as in Figure 4, last month's installment) and retained as a part of the equipment. By placing this plate just below the stage (Figure 6), or between the stage and black mirrors (Figure 7), many of the otherwise plain effects will be shown in varied colors. When examining crystals the mica plate may be used to produce beautiful colored backgrounds, and at the same time for varying the crystal color patterns.

Crystals producing color belong to the class of double refracting materials. Others simply appearing as seemingly luminous crystals on a dark background may also belong to this class, but transmit a limited amount of one of the polarized rays to the analyzer, with the result that few or no colors are produced. Often a slight fringe of color may be seen around the edges and very thinnest portions of such crystals.

Figure 6: **The polarizing apparatus in use. Mica plate is being held below the microscope stage**

Crystals of the cubical system have no polarizing effect and therefore appear only as shadowy forms on the field.

Quite frequently improperly prepared or dulled surface crystals of double refracting materials may appear to belong to the cubical system. When this condition is suspected, the addition of a few drops of water to the crystals while examining them will show whether or not this is the case. If the crystals are double refracting they will immediately appear as such when their surface is wetted.

In most cases it is relatively easy to prepare chemical crystals for either permanent or temporary mounting. A great many chemicals will crystallize in beautiful forms from water or other solutions. The same chemicals will often give forms in dilute solutions different from those obtained from stronger solutions. Ordinarily a few drops of dilute solution may be placed on a clean slide and set aside in a cool place for a few hours. The best results are obtained when the slide is cleaned thoroughly with the cleaning solution mentioned last month, so that the chemical solution spreads out, preventing an otherwise concentrated mass of crystals. In other cases crystallization may be speeded up by gently applying heat to the slide. Few chemicals produce the best crystals by this method, however, and slow crystal growth is preferable.

Potassium dichromate, potassium chlorate, potassium oxalate, oxalic acid, copper chloride, copper sulfate, nickel ammonium sulfate (one of the most beautiful crystals formed), cobalt chloride, and innumerable other such chemicals may be crystallized in this manner.

Other chemicals may be prepared by melting a small amount on a glass slide and allowing to cool slowly. Salicin, menthol, sulfanol, and others may be treated in this manner, but are preferably dissolved and crystallized from their respective solutions in liquid.

Materials such as starch, plant sections, and some crystals are most beautiful when mounted in Canada balsam. It is a good plan to try the balsam mounting in all cases, since crystals are quite often more brilliant when embedded in this medium.

A most beautiful sight may be seen by preparing a slide containing a solution of nickel ammonium sulfate and patiently watching it under the microscope until crystal growth begins. The thrill of seeing crystal growth with po-

Experiments that are Beautiful but Equally Practical . . . Many Useful Applications in the Industries . . . Examining Structural Models

larized light, especially against a dark field, undoubtedly constitutes one of the "ultimate thrills of the microscope."

Many useful applications of polarized light have been made in industry, such as measuring the concentration of sugar solutions, the analysis of stresses in various machine parts and beams, and the study of liquid flow around various shapes. Measurement of the concentration of sugar solutions is based on the fact that the plane of polarization of light transmitted through the solution is rotated, and the amount of rotation is a function of the concentration. This cannot be shown with an ordinary microscope, since a fairly great depth of solution is required. A special instrument known as the "sacchrinometer" is used for this purpose.

STRESS examination in structural parts is shown in the accompanying illustrations of two small Celluloid angles (Figure 8), one with a rounded, smooth corner, the other with a sharp, square corner. The small areas enclosed within the circles should be placed in the field of vision under the microscope, and by clamping one leg to the stage as shown in Figure 7, the corners may be stressed by pressing inward on the free end. The effects are shown plainly in Figure 9. Notice that the sharp-cornered angle is very brilliant when seen against a dark field, while the smooth, rounded corner is only slightly luminous; and further, that the illuminated area is more evenly distributed. These lighted areas bear an almost direct relationship to the amount of stress, and show clearly that rounded corners distribute stress, whereas sharp corners concentrate the same stress in small areas.

In actual practice the stress in variously shaped machine parts is studied by making scale reproductions of the part under investigation in Celluloid and studying the effects under polarized light. Gear teeth shapes, beam shapes, structural frames, and many other such subjects are studied by this method. [This was described in SCIENTIFIC AMERICAN, November 1922, pages 280-283; "Looking at Stresses," by Prof. M. M. Frocht.—*Ed.*]

Another easily prepared illustration of stress may be obtained by clamping

Figure 7: **Mica plate held lower than in Figure 6. A Celluloid angle being examined for corner stresses**

a small glass plate between the jaws of a small clamp or calipers, as shown in Figure 10. When either point of contact between clamp and glass is viewed with the analyzer set for dark field, the effect shown will be seen. Notice how the clamp jaw is attempting to push a wedge-shaped area of glass away from it, which is consequently being held back by similar wedge-shaped areas on either side. The two dark areas between the three wedges are holding all three together at the same time. These dark areas are "between two fires," so to speak, and since they are holding together three parts of a body, two of which are being stressed in one direction and one in the opposite direction, they are said to be "in shear stress."

The effect of stress as shown in the illustrations is produced because singly refractive materials, such as glass and Celluloid, often become doubly refractive when compressed. By placing the

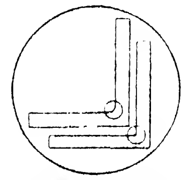


Figure 8: **The two angles of Celluloid employed in the experiment**

mica plate below the stage the stress effects will be seen in varied patterns of color.

THE flow of liquids around variously shaped objects, such as experimental boat hulls, has been studied with polarized light in a most interesting manner. A water canal with glass sides is placed between a large illuminated polarizer and analyzer. The canal is connected to large pumps which circulate the water at the desired speed. The scale models of sections or other objects are then arranged in the water on wires, so as to be held within the field of vision of the polarizing apparatus. So far, not a thing can be seen, other than the usual light and dark fields. However, with the field adjusted to the dark position, a regulated amount of oil having a certain refractive power is introduced into the water canal and immediately things begin to happen. Each small particle of oil produces a luminous path showing every minute eddy and current around the object.

Editor's note: So far as we know, there is no general treatise on polarized light, of a suitable nature to recommend to the amateur as a theoretical and practical guide. All physics textbooks explain polarized light, of course, and such books as Edser's "Light for Students," and Houston's "Treatise on Light" contain chapters on its theory. The author of the above article recommends Thorpe's "Dictionary of Applied Chemistry," and Clark's "Practical Methods in Microscopy."

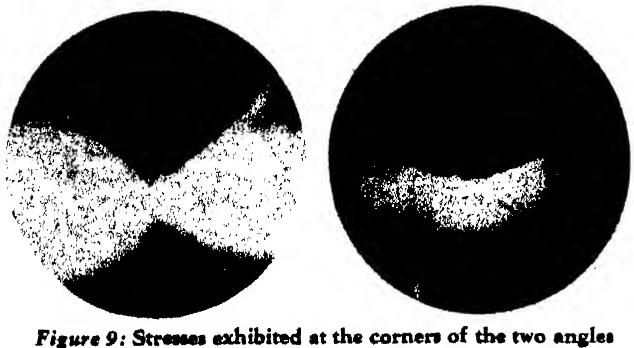


Figure 9: **Stresses exhibited at the corners of the two angles shown in Figure 8. The rounded one is the one at right**

Figure 10: ***Left,*** **Glass plate under localized stress.** ***Right:*** **The stresses at one of the (magnified) jaws. See the text**

Did Man Exist in the Miocene Epoch?

By J. REID MOIR
Fellow of the Royal Anthropological Institute,
Member of L'Institut International D'Anthropologie

IT IS now some 25 years since the first flint implements were found in a deposit of the Pliocene Epoch in Suffolk, England. In those days it was generally believed, with an almost dogmatic intensity, that the earliest human beings had only appeared on this earth at a much later epoch, and the announcement of the discoveries in Suffolk was the signal for the waging of a fierce scientific battle, which continued with increasing violence for many years, and has only recently come to an end. At long last, the majority of competent investigators who have examined the specimens excavated from the Pliocene deposit of Suffolk are agreed that they represent the work of man, and with this acceptance the first stage in the fight for the recognition of the greater antiquity of man may be said to have terminated.

The Suffolk Bone Bed, as it is called, in which the Pliocene works of man have been discovered, is clearly from the nature of its contents formed largely of the remains of an ancient land surface which existed in eastern England for a very prolonged period prior to the submergence of that area beneath the sea which laid down the shelly sands, called the Red Crag, which overlie the Suffolk Bone Bed. We know that this land surface must have been present for a greatly extended epoch of time, because in the Bone Bed are found the remains of certain terrestrial mammals which by their types can be referred with confidence to the Miocene Epoch, while others are to be relegated to phases of the Pliocene. The Suffolk Bone Bed was laid down toward the close of the latter epoch, and thus we can say that the flint and bone implements in this deposit cannot be later in date than the Pliocene.

But recent examination of the large series of specimens now available for study has shown that we are not dealing with implements of only one kind and period in the Suffolk Bone Bed. This examination has, in fact, made it clear that at least four distinct groups of artifacts occur in this deposit, and that these were made by successive races of men who inhabited eastern England before the marine beds of the Red Crag were laid down.

TO attempt to explain what happened in the remote past in this part of the world, it is necessary to imagine our present land surface with its various deposits containing relics of man, together with the material evidences of our modern culture, being by some process destroyed and finally swept by marine action into a widespread residual accumulation. In such a deposit would lie, cheek by jowl, artifacts of very different kinds and antiquity. The manner in which the Suffolk Bone Bed might have been formed is shown in Figure 1, where the Red Crag Sea is supposed to be encroaching upon a slowly sinking land surface composed of early Pliocene and Miocene deposits. As the land surface was eroded by marine action a shore-line accumulation would be formed by slow degrees, in which would be incorporated flint implements and mammalian remains embedded in the deposits attacked by the sea, and those lying upon the land surface.

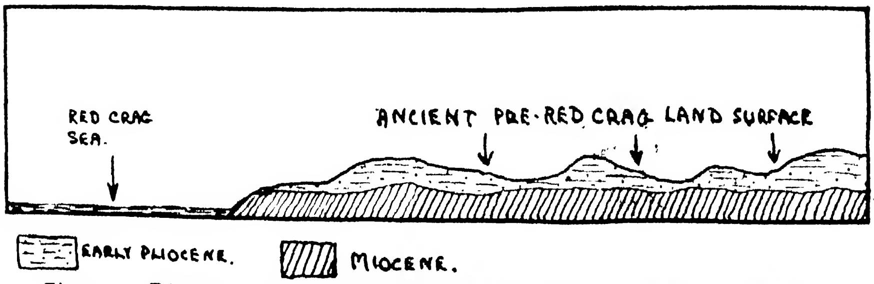


Figure 1: **Diagram showing the ancient land surface of eastern England in process of submergence by the Red Crag Sea. The encroachment was gradual**

For a considerable time after the first announcement was made of the discovery of Pliocene flint implements it was necessary, in view of the opposition to this claim, to concentrate upon the primary task of establishing the fact that these specimens had been humanly flaked. This led to the carrying out of a prolonged series of experiments in the natural and artificial

Figure 2: Left. **Primitive implement**
Figure 3: Right. **A rostro-carinate**

fracture of flint, and threw much light upon an hitherto obscure problem. But the further critical examination and classification of the Pliocene artifacts of eastern England which it has now been possible to undertake, is leading to certain unexpected and far-reaching conclusions regarding the antiquity of the specimens, and it is my purpose briefly to set forth these conclusions here.

IT will be realized that it is by no means an easy task to decide as to the relative age of the flint implements assembled in the Suffolk Bone Bed. In the case of the remains of terrestrial mammals, the paleontologist can sort them out according to their various types, and by means of acquired knowledge assign them to the Miocene and early Pliocene Epochs. But, in dealing with the flint artifacts, no such acquired knowledge is available. It is not known, by other discoveries in different parts of the world as it is with the mammalian remains, that a certain type of primitive flint implement found in the Late Pliocene bed of East Anglia in a derived state occurs elsewhere in an Early Pliocene or Miocene accumulation under conditions which make it prob-

able that such specimens were in use in either of those epochs.

It becomes necessary, therefore, to approach this problem from another angle, and to endeavor, by an examination of the types, patination, and condition of the Suffolk Bone Bed specimens, to form a judgment as to their relative antiquity. As is known, the somewhat unsatisfactory term "patination," as applied to the flaked surfaces of a flint, refers to the changes in color and texture which, so far as we know, are brought about by some process at present not satisfactorily explained, operating over a considerable period of time.

When the Pliocene implements of eastern England are examined it is seen that among them are numerous examples which exhibit, on one and the same specimen, flaking of one or more periods, and that the patination of these non-contemporaneous flake-scars exhibits a markedly different coloration. A similar state of affairs is, of course, well known among flint implements of later ages, and testifies to the fact that ancient man, when he sometimes found a specimen made in the past, and already patinated, proceeded to re-flake it to suit his own purposes.

IT IS also apparent, in the case of the Pliocene implements, that the four types of patination represented upon the reflaked specimens can be precisely matched by that to be observed upon a series of artifacts which are each different in their forms and condition. Thus, for example, the oldest implements are thick and coarsely flaked, exhibit a peculiarly archaic washed-out yellow color, and have evidently been subjected to very considerable striation and abrasion. The latest specimens, on the other hand, are usually white or light blue in color, are little if at all abraded,

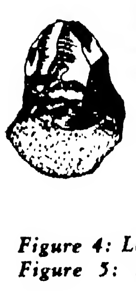



Figure 4: Left. **Primitive hand axe**
Figure 5: Right. **A side scraper**

and are not thick and coarsely flaked. This can easily be recognized by an examination of the illustrations accompanying this article. Those referable to Group 1 (Figures 2 and 3) in which rostro-carinates, or beak-shaped implements occur, are clearly to be distinguished from Group 2 (Figures 4 and 5), in which, as in Group 3, a primitive hand-axe has appeared, while Group 3 (Figures 6 and 7) appears to be distinct from the two preceding groups, and from Group 4 (Figures 8 and 9).

There cannot, in fact, be much doubt that in these various groups of Pliocene implements we see a gradual improvement in technique, and this fact, together with the evidence afforded by the differing patinations, makes it reasonable to conclude that we are dealing with four "industries," the development of which must have occupied a considerable space of time. There appears, indeed, to be as much divergence in the matters mentioned between Group 1 and Group 4 of the pre-Red Crag implements as there is, for example, between the Early Chellean and Late Acheulean hand-axes of paleolithic times, and it may well be that the gap in time between Group 1 and Group 4 of the Pliocene industries is actually greater than that separating the paleolithic industries already mentioned above.

We see, therefore, that although these Pliocene implements are now found as a residual deposit, laid down


Figure 6: Left. **Primitive hand axe**
Figure 7: Right. **Square scraper**

toward the close of this epoch, they nevertheless extend backward to periods long prior to that in which the Suffolk Bone Bed was accumulated. Is it possible more accurately to define these periods? Among the large series of specimens recovered from the Suffolk Bone Bed is a rostro-carinate which appears to be of much significance, for it has attached to various parts of its surfaces patches of material which, so far as a very careful visual examination goes, is completely indistinguishable from what is known as Diestian sandstone.

The Diestian deposit, which occurs in Belgium, and at one time existed in Eastern England, is represented in the Suffolk Bone Bed by rolled lumps which, when broken open, often contain the casts of shells and other objects. The tooth of a mastodon was found many years ago embedded in this characteristic material, and its discovery showed that this creature existed prior to the Diestian period of Lower Pliocene times. In the same way the maker of the rostro-carinate implement mentioned must, if my conclusions are correct, have lived prior to the Diestian epoch. Moreover, the patination of the flake-scars of this specimen is precisely similar to that to be observed upon others which are clearly later in date than Group 1 of the pre-Red Crag implements.

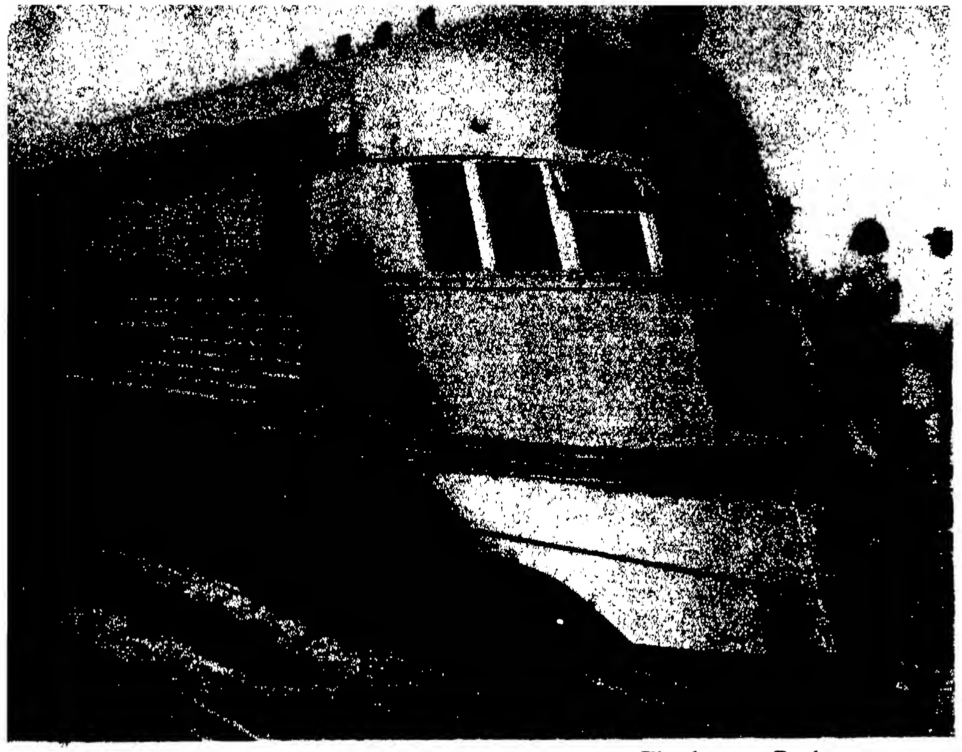
It would seem necessary, therefore, to relegate the Group 1 specimens to some period still further anterior to the Diestian epoch than is the rostro-carinate to which reference has been made. If these conclusions are found to be sound, they give us much additional information upon the question of


Figure 8: Left. **Scraper, Pliocene**
Figure 9: Right. **A side scraper**

the antiquity of man. We have seen that there is reason to believe that well-made rostro-carinates and other implements were being made at least as early as Lower Pliocene times, perhaps upward of a million years ago. But, while this is the case, it seems obvious that, old as these works of man are, their forms and flaking are not such as we would associate with the first efforts of emerging human beings to shape flint intentionally.

The specimens of Group 1 are in many cases of eolithic types, such as were first found by Benjamin Harrison in very old deposits in Kent, England, but the pre-Crag examples show an advance upon the Harrisonian eoliths in that they are usually made from intentionally struck flakes. It appears that in the pre-Crag Bone Bed of Suffolk, we have now revealed a series of industries made by various races of people who existed long before the later makers of the well-known paleolithic hand-axes came upon the scene. It is also possible that these implements which now lie in the Suffolk Bone Bed were at one time embedded in various deposits which, in the course of great periods of time, had been laid down on the old land surface of Eastern England. From these they were finally removed by marine action when East Anglia sunk beneath the sea, about 500,000 years ago, and today they are confronting archeologists with a very complex and important problem.

IF the evidence they afford can be read aright, we shall be able to know much more about the antiquity of our species, and perhaps at last be enabled to say when the momentous appearance of man upon this planet took place. But this cannot be done at present. The trail of ancient man is leading us into strange and archaic regions and its beginnings remain hidden in the mists of antiquity.



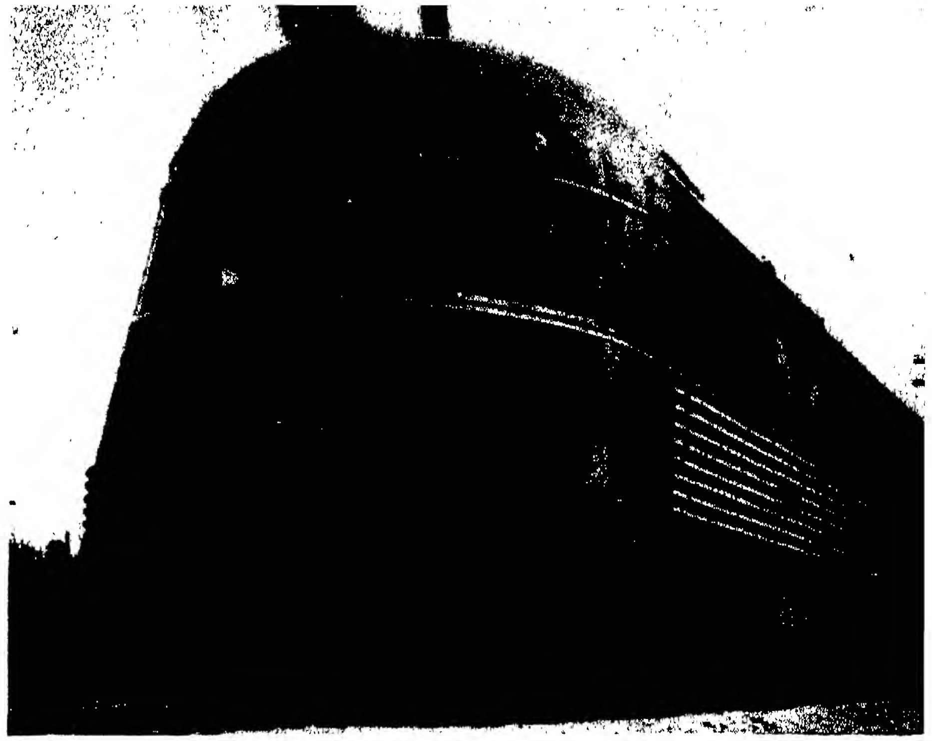
A leader of the tribe of Diesel-powered main-line trains: The famous *Zephyr*

DIESELS ON RAILS

Diesel Most Economical Prime Mover . . . Offers Solution to Demand for Lower Operating Costs . . . Main Line or Switching Service . . . Record Runs Point the Way

By GEORGE W. CODRINGTON
President, Winton Engine Corporation

THIS is the last of a series of three independently written articles concerning railroad motive power. Since the Diesel engine for main-line work is the newest entry into the field, it quite naturally came after publication of the articles on steam locomotives and on electrification. From the three we have no conclusion to present as we believe that our articles have given sufficient facts for the reader to judge for himself. However, since Mr. Codrington's article was necessarily written concurrently with the two former ones three months ago, it was impossible to present within the body of the story any detailed figures as to operating costs of the new type of train. Therefore, for further guidance of interested readers, we present in the Digest section of this issue certain late information concerning operating costs of the famous Burlington *Zephyr* which now is on a regularly scheduled run. These cost figures were obtained independently of Winton.—*The Editor.*



A Down-Easter, New England's first venture into the field of Diesel-powered trains

THE railroads of the United States are confronted today with the most acute crisis in their entire history. Whether any of the programs for rehabilitation that are now being offered are adopted or not, I am satisfied, in view of the courage and genius for achievement which have consistently characterized America's railroad executives, that they will find a satisfactory solution to their present difficulties. Aside from any program that may be adopted, the fact remains that the railroads will still be faced with an imperative demand for reduced operating costs. Because I am entirely confident that this demand for more efficient operation will remain after all of the other now pressing problems have been resolved into a satisfactory answer, I am optimistic with reference to the future of the Diesel engine in railroad service.

We know that the Diesel engine is the most economical prime mover available, and we know further that this type of power plant can be successfully applied to main line railroad trains and locomotives. In short, because Diesel power provides the most satisfactory answer to the railroads' demands for economy, a most vital need at present, I feel certain that they will adopt this type of power as widely and rapidly as their financial condition will permit. This does not seem unduly optimistic to those who are familiar with the history of the Diesel engine in other fields as well as with recent engineering advances, some of them quite revolutionary in character, in the design and construction of the Diesel-type engine.

Operating figures for the high-speed, main-line, Diesel-powered passenger trains which have recently been placed in service in this country do not cover a period long enough to be conclusive. Nevertheless, such figures as are available indicate the possibilities of this type of equipment and they are most encouraging. For instance, figures compiled for one month's scheduled service of the Burlington *Zephyr* show its operating cost to be only 25 percent of the total revenue derived from its service. So great has been the public's acceptance of this train, that its capacity is being increased from 72 passengers to 112 passengers, by the addition of a fourth car now under construction.

The Diesel-type engine presents advantages other than economy which appeal to progressive railroad executives, but on the basis of economy in operating cost alone, the Diesel engine cannot be ignored when plans for securing more efficient operation are being formulated by our railroad leaders. The introduction of Diesel power into main-line railroad service comes at a time which, although most distressing to the railroads themselves, is quite favorable to the adoption of new equipment. The railroads must do something to improve their condition and one of the things that presents itself as a solution to a major problem is the Diesel engine. To provide means and ways whereby the roads may emerge from the distressing condition of the past five years into the light of a new and more profitable era presents a challenge which railroad executives have accepted with courage and confidence. In no other phase of the situation has this been more forcefully demonstrated than in the introduction of revolutionary new equipment, such as the new streamlined, high-speed passenger trains.

While the percentage of obsolescence in equipment is extremely high, nevertheless many roads will undoubtedly find it impossible to make extensive purchases in this direction for the present. This will probably result in revamping some of the equipment now in use. However, even in the face of such a condition, the Diesel engine stands a good chance of displacing some of the motive equipment now in use. At present, Diesel locomotives are being developed in 600, 900, 1800, and 3600 horsepower units, suitable for main-line and switching service. The economy of these new power units gives every promise of resulting in their widespread adoption by railroads.

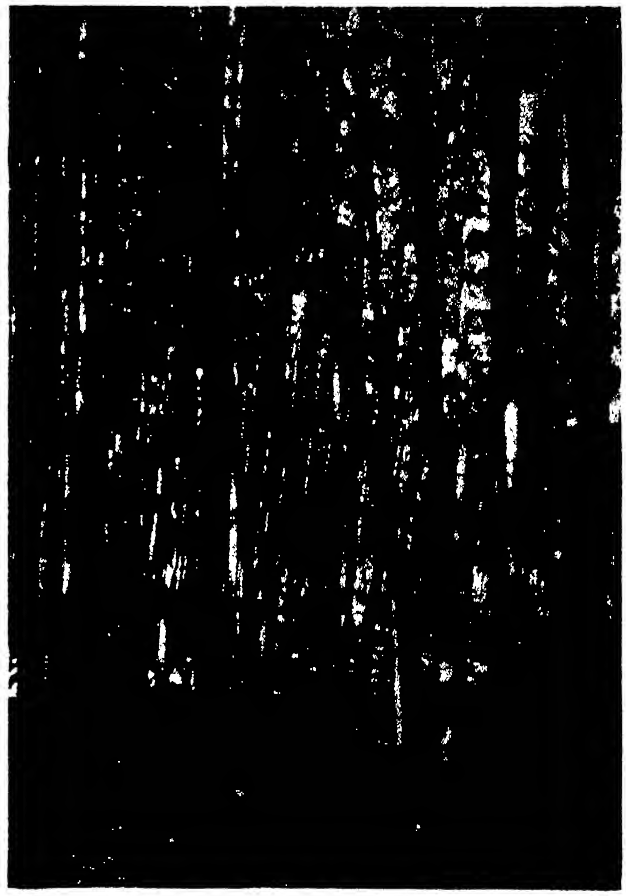
Another factor which must be considered is the fact that conservative estimates place the deficiency in purchases for maintenance alone which has accrued during the last five years at 400,000,000 dollars, which is the difference between the expenditures made by the railroads for maintenance materials in that time and the expenditures the railroads would have made to move the same volume of traffic had they spent proportionately as much during the period out of earnings as they did before the depression. This deficiency cannot be permitted to go much higher without disastrous consequences.

The present low earnings of the railroads are, of course, due to loss of traffic. Some of this loss is due to general economic conditions and some of it to competitive forms of transportation. The new high-speed, streamlined, passenger trains offer one method, and a most important one, of returning a large part of this lost traffic to the railroads. New engineering advances have made such trains possible, and it is fortunate that streamlining, air-conditioning, and the Diesel engine can be combined in such equipment, in order to provide the essential features of comfort, cleanliness, speed, and economy. The Diesel engine can hardly be left out of such a picture of the future of railroads.

One that gave such a good account of itself on a transcontinental run that it smashed many railroad records

AN ORIENTAL PLANT

By FRANK A. MONTGOMERY, Jr.



In the grove of giant timber bamboo on the fa near Savannah, Ga. This grove is about 35 years old

ON a farm on the Ogeechee River, near Savannah, Georgia, the Federal Government is conducting experiments with some 275 species of bamboo, with the hope of assisting southern agriculture to meet the domestic demand for this commodity with a steady supply. As a result of these experiments groves have been and are being established in many states where the climate is not too rigorous. With their waving crests and almost impenetrable thickets of round, reed-like stems, these groves are not only commercially valuable but also an attractive addition to the landscape.

About two million dollars' worth of bamboo is imported into the United States each year, and some time ago the Department of Agriculture and other interested organizations and individuals decided to investigate the possibilities of growing at least a part of this volume in the South. The results of these painstaking experiments are now becoming available and it may be said that the growing of bamboo will become a source of profit to southern farmers—a crop that may be likened to the fruits of orchards on the farms. Bamboo grown in the South is being used in a variety of ways, and bids fair to become increasingly profitable.

THE grove at Savannah is part of a 46-acre farm known as the "Barbour Lathrop Plant Introduction Garden." It was presented to the Federal Government by Lathrop who has long been interested in collecting bamboo plants. The grove itself was started from Japanese plants imported by a Cuban, Andreas E. Maynelo, and was called to Lathrop's attention as one of the largest groves of bamboo in the United States. When it was purchased and turned over to the government about a decade ago it covered only about half its present area. But it has rapidly increased in size and importance, until at present, bamboo is being shipped from the grove for paper making, the manufacture of tooth-brush handles, yacht masts and booms, flagpoles, plant stakes, fishing poles, radio aerials, furniture, ladders, and many other commodities.

This versatile plant has many other uses. One which is becoming increasingly important in America is the use as food of bamboo shoots, or tips that have just come up out of the ground. These shoots—sliced, peeled, boiled, and served in butter sauce—have been among the favorite dishes of the Orient for centuries. Quite a few Americans have acquired a taste for them and a wider market for the food is gradually being developed, much of the shoots being canned for the trade.

The great timber bamboos which form the spectacular and successful grove in Georgia are also extremely useful in their growing forms. They act as effectual windbreaks and they have a distinct appeal to the landscape gardener. Very little decorative bamboo, however, is to be found in the United States, mainly because people consider it unsuited to the rigors of North America's climate. This is a mistaken idea and it is a fact that bamboo will grow in the east as far north as Maryland. In England and along the south coast of France there are many strikingly beautiful bamboo gardens. Since bamboo is an evergreen, these gardens, from a standpoint of beauty, are as attractive in winter as in summer. In fact, the green of a bamboo grove against a background of snow is a sight long to remember. The eastern shore of Maryland offers many such sights during the winter months.

THE most important of these plants being grown in the South at present, both in the Savannah grove and elsewhere, is the large Japanese timber bamboo. In Japan, and especially in China, this species is a veritable staff of life to the natives. It produces food and shelter and many of the other necessities and comforts of existence for at least 300,000,000 people. It was, in fact, the ingenuity of Oriental peoples in the utilization of bamboo that first attracted American manufacturers to the possibilities of this remarkable plant, and which has led to the present status of bamboo culture in this country. It was believed that if users of bamboo in this country could have a ready access to a domestic supply, they would develop new Occidental uses. Such seems to be the case, for already the stem of the bamboo is being put to uses undreamed of by Orientals.

For example, many growers of pecans, almonds, walnuts, and prunes have discovered that there are no poles as light and efficient as bamboo poles for harvesting their crops of nuts and fruits, while other orchardists are beginning to use light bamboo ladders when picking their fruit. They are also using bamboo poles as props for fruit-laden limbs. And, as has been mentioned, bamboo for tooth-brush handles is popular, while the familiar bit of bamboo used as a phonograph needle has long been a familiar sight to Americans. The possibilities of bamboo, so growers and manufacturers insist, are extensive.

Strangely enough, in view of its size, bamboo is a grass and not a tree at all, as some people have long thought. The hollow, jointed stems are very dissimilar to tree trunks, for they are produced in a single season from a mass of roots and rhizomes, as grass stems grow from sod.

IN THE OCCIDENT

Bamboo as a Farm Crop . . . To Supply a Two Million Dollar Demand . . . 275 Species Being Investigated . . . New Uses Are Developing

These stems, when they burst through the earth along about May, are as large in diameter then as they ever will be. When the young bamboo shoots first appear they look for all the world like shells from a small-calibre field gun, and they are covered with overlapping scales like the husk of an ear of corn. At this stage they are extremely tender, and a slight kick will serve to break them off on top of the ground. Corn, wheat, oats, rye and barley are all near relatives of this unusual plant.

Bamboo plants have more or less rounded stems divided into joints, each joint marking the point where there is a partition or brace in the stem. These stems are practically all hard and woody when mature and capable of withstanding a great amount of stress and strain in spite of their lightness. They produce flower and seed clusters resembling those of rye and barley. However, with most varieties of bamboos, flower and seed production occurs at extremely rare intervals; quite often 50, 75, or even 100 years intervene between blooming times. Many bamboos die immediately after flowering. The plants grow with great speed, in some varieties as much as sixteen inches in twenty-four hours, and they reach considerable heights, some in the Georgia groves being 70 feet high.

Clump bamboo growing in Florida. This is one of the most spectacular and useful of the various bamboos

THE plant is indigenous to mild climates, none ever having been found native to the colder temperate regions. There are only two native species in the United States—the canes at one time found so plentifully in the southern canebrakes from Virginia to Louisiana and along the lower reaches of the Mississippi River. Central and South America boast of more than 150 species, but Asia, and especially China, is the richest of all regions in bamboo species. Nearly 500 different kinds of bamboo have been identified, and of this number approximately two thirds are found in Asia.

Bamboos may be divided roughly into two groups: Those that spread in all directions by means of underground runners, and those that grow in more or less compact groups or tufts, spreading slowly by a gradual enlargement of the clump. The giant timber bamboo spreads rapidly in good soil and attains a height of 60 to 70 feet, with stems three to five inches in diameter. This is one of the most useful of bamboos, especially for domestic purposes. Two other bamboos similar to the giant form, but hardier and smaller, have been found adapted to climates as far north as Kentucky, Arkansas, Tennessee, northern Texas, California, and western Oregon and Washington. These forms are known as the forage and stake bamboos and the dwarf hardy bamboo. Under favorable soil conditions these bamboos reach a height of 20 to 25 feet and may act as valuable storm shelters and windbreaks, as well as furnishing poles, canes, stakes, and so on.

Two other bamboos of the clump style have been found suitable for the warmer parts of Florida and to some extent for extreme southern Louisiana and Texas. They are the Calcutta bamboo and the Indian cane bamboo. Both grow readily from seed, which is produced in India. They are rather slow growers, beginning to yield fair-sized poles in clumps around the age of five years. The stems are nearly solid and are therefore rather heavy in comparison with some other species. When full grown, 80 feet is an average height.

The first systematic attempts to introduce bamboo in the United States were made by the Federal Government about 25 years ago. So little was known of proper cultural methods, however, that there were many failures in the work. As it went forward, more knowledge was accumulated until at present, as exemplified especially in the grove at Savannah, most of the difficulties of growing bamboos in the United States have been overcome.

OWING to bamboo's relationship to the canes found growing wild in the bottom lands throughout the South, it was once believed that to grow well it must be set out only in damp, low places. Some species, it is true, do grow best in such places, but it has been learned that most varieties thrive wherever cotton is grown and really prefer fertile, well-drained soil. Thus is it easy to understand why the plant has been so successfully grown in all the South Atlantic States, the Gulf Coast States, and parts of Kentucky, Tennessee, and, in fact, wherever the climate is not too severe. More and more interest is being shown in this one-time curiosity, until undoubtedly the day is not far distant when a crop of bamboo to the farmers of this country will seem no more unusual than a crop of corn.

●

The question "How Bright is a Lightning Bug?" is answered in a short but highly interesting article by Prof. W. A. Parlin, scheduled to be published in an early number.—The Editor.

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors
ALEXANDER KLEMIN
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Matching Colors Photo-Electrically

THE problem of matching colors exactly is of vital importance to many industries. In the manufacture of textiles, ceramics, dyestuffs, beverages, inks, paints, and many other commodities where color is involved, wide discrepancies often occur which have an adverse effect on sales. Varying degrees and qualities of light, as

Two cloth samples being inserted in the photo-electric color matcher

well as differences between human eyes, often make it impossible to reach an agreement on a color "match." However, by means of an ingenious application of the photo-electric cell, there has been developed a device called Hays Telecolor which is completely free from all such influence. It not only tells definitely whether or not two samples of a color are an exact match but also shows at what points of the color spectrum these differences occur. By means of color filters it is thus possible to make up a chart from which color corrections can be quickly and accurately made. For example: If in breaking down the color components of a "standard" and a "test" sample, the operator finds that there is a difference in the readings of 1.25 percent when the green filter is used, this would indicate that there was 1.25 percent difference in color in the green band of the spectrum.

Briefly, Telecolor is an instrument weighing less than 25 pounds in which is located a light source and two photo-electric cells. These are connected in a circuit with an indicating galvanometer and a calibrated variable resistance which is used for balancing the circuit and indicating color differences in percentage of reflection. The equipment is so designed that it can be used on any lighting circuit and is not affected by differences in voltage.

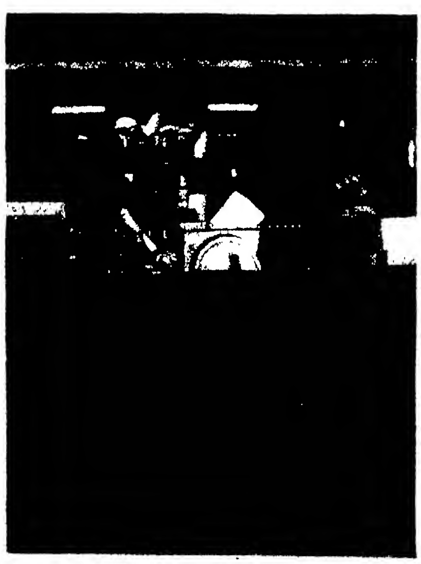
The device may be used not only for checking colors of cloth and so on, but also the opacity of liquids or solids or the transmission of light by various types of glass.

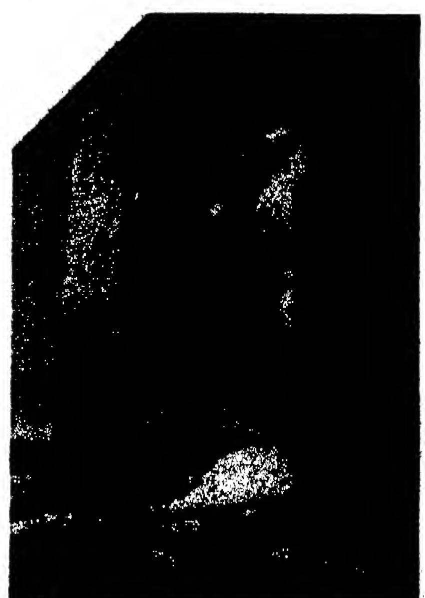
Top-Icing Cars With Snow Ice

"FOR years it was the habit of steam lines to use block ice for cabbage and lettuce, a process that broke fully 7 percent of the crates. Some research department finally conceived the idea of using electric motor-driven machines, mounted on light trucks for movement to car doors, that pulverized blocks of ice, blowing the particles through a hose." This statement is taken from an article by George Creel, on "The Railroads Wake Up," which appeared in a recent issue of *Collier's*.

Top-icing refrigerator cars of green vegetables with snow ice provides moisture and refrigeration to insure arrival of the produce in an attractive condition, thereby commanding the highest market prices. It is suitable for use with all such green vegetables as cabbage, celery, corn, lettuce, peas, spinach, beets, carrots, cauliflower, broccoli, endive, and parsley.

With a machine developed by Link-Belt, called the Ice-Slinger, an operator at the car door manipulates the discharge hose, thus placing a heavy blanket of snow ice on the crates or hampers. Top-icing eliminates the necessity of bunker icing and prevents center heating. The settling of the ice over and around the contents provides a packing effect which reduces damage due to rough handling. The high speed blast of ice forces out all warm air, and thus precools the car. "Slinger-iced" cars have crossed the continent without re-icing.





***Left:* The "ice-slinger" mounted on a truck, pulverizing blocks of ice. *Above:* The delivery hose "slings" snow ice into a refrigerator car**

Heredity, Germs, in Dental Decay

HEREDITARY immunity, or lack of it, and the presence of a germ, bacillus acidopholis, in the mouth seem to be the fundamental factors in the decay of human teeth, the Michigan Academy of Science,

Arts and Letters was told by Dr. Russell W. Bunting, of the University of Michigan Dental School, in summing up five years of group research in this field.

Heredity plays a definitely known part in this most discussed disease. About 7 percent of the hundreds of persons studied showed a natural immunity to dental decay. At the other extreme, some 10 percent had very active caries which was controllable only by the most heroic measures. Most persons fall within the middle 83 percent who may be protected from dental caries by proper dietary measures, Dr. Bunting stated.

Among the large non-immune majority, the thing that seems to foster the heavy growth and activity of the bacillus is a diet rich in carbohydrates, especially sugar. A high bacillus count, in turn, was almost always found to be associated with a high rate of decay. This has been repeatedly checked during the past five years at an orphanage of 300 children, where the diet was well controlled. At the orphanage it was found that caries could be practically eliminated, except in the over-susceptible group, by the feeding of a uniform, fairly adequate, low sugar diet, reported Dr. Bunting.

The whole problem of dental caries is not solved by these findings, which are complicated by the factors of age and general health, Dr. Bunting was careful to state. Certain "nots," discovered from the study are as important as the positive findings, he pointed out. One is that decay is not determined by the hardness or softness of the teeth. Another is that the amount of calcium or phosphorus in the blood exerts no influence, nor does the ammonia, acid, or diastase content of the saliva. Poorly formed teeth, it was found, are no more liable to decay than normal ones, while an unclean mouth is not necessarily a sign that the teeth are decayed or will decay.

SUPERFINE

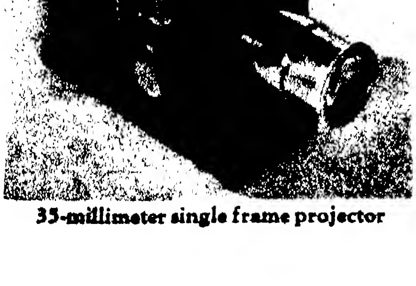
BY A special process, aluminum can be drawn into a wire .0001 inch in diameter. One pound would reach nearly around the earth.

Picture Projector

IT is often desirable to project "stills" made on 35-millimeter film so that a group may view them. In business offices or in sales conferences 35-millimeter film used instead of cumbersome lantern slides and their still more cumbersome projecting equipment proves highly satisfactory in the results obtained.

E. Leitz, Inc., has recently placed on the market a projector for such pictures made with miniature cameras. The projector itself might be called a miniature because it is only 5½ inches high, 7 inches long, and 2½ inches thick. Made of Bakelite, it weighs only 2¼ pounds. It uses either 50- or 100-watt projection bulbs. Of extremely simple design, it can effectively be used on a table to project screen images up to about six by four feet. It uses, of course, positives which may be made from either ordinary black and white film or from Leica Dufaycolor pictures.

This projector is recommended by the maker for equipment demonstrations from pictures made in the factory, to show people at work or products in actual use, to show graphs and printed pages, or for the many purposes to which the older and less satisfactory lantern slides may be put.



35-millimeter single frame projector

Chemicals in Air Conditioning

CONDITIONED air is usually dried by cooling it below its dew-point to throw out excess moisture. Recently, however, a process of chemical drying has been developed by C. R. Downs, in which the great affinity of calcium chloride for water is utilized. The device is known as the Calorider and employs a combination of calcium chloride and other materials for dehumidification and deodorizing of air.

The system is adapted both to industrial work and to comfort air conditioning. The air passes through numerous cascades of solution and sweeps over shallow trays containing the liquid. After it is partially dry, it passes through lump Caloride where additional absorption of moisture reduces the relative humidity to about 25 percent. Cooling coils are supplied to remove the small quantity of heat liberated during the drying. For winter operation, the Caloride is removed and warm water put into the apparatus to increase air humidity to the desired extent.—*A. E. B.*

Operating Costs for the "Zephyr"

AS promised on pages 308 and 309, we give here a summation of the experience gained in the first few months of operating the Burlington *Zephyr*, America's first streamlined Diesel-electric train.

First of all an increase of from 150 to 200 percent in number of passengers carried, a reduction of almost half in operating expenses, and a cost for fuel and lubrication only slightly more than one fourth the previous cost are among the advantages which have accrued to the Chicago, Burlington and Quincy Railroad. According to figures received by the General Electric Company, which supplied the electric equipment, savings in operating expenses have averaged approximately 4450 dollars per month, or 53,400 dollars per year.

Patronage on the Lincoln-Omaha-Kansas City run has increased beyond the capacity of the train, so that a fourth section is being added to the original three-section articulated train, to increase accommodations from 72 to 112 passengers. So successful has

PROGRESS In This Age Of Science

As Told to Scientific American

By WALTER P. CHRYSLER

THE world today needs more than ever men of trained intelligence—men who can use their minds scientifically—men who can look inside and outside and all around a problem, getting down to its fundamentals and finding a practical, workable answer.

The world needs well-rounded men—men who are scientists in the true sense—men who know something about everything and everything about something—men of inquiring mind who are curious as to the why and wherefore of things and equipped with the proper scientific training to find out.

I call that type of man intelligent.

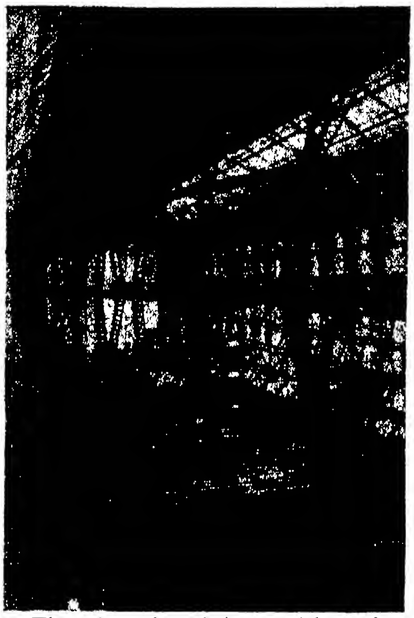
As I see it, intelligence is versatility—adaptability to environment—ability to change and to suit one's methods to conditions.

And conditions in this country are changing, as we all know—changing, I believe, for the better. This is too big a country, with its vast resources of men and material, not to recover eventually all that has been lost and more.

It seems to me that the institutes, colleges and universities of America, in helping to develop the scientific attitude of mind in their students, are laying a sound foundation for this country's growth.

It is this happy combination of scientific training and practical experience which is responsible in no small degree for the many great practical improvements in automobiles — improvements which the motorists of America recognize as fundamental contributions to greater riding and driving satisfaction.

The right kind of thinking plus the right kind of practical skill—that's the foundation of progress in engineering, in industry, in business, in every human endeavor.



The triangular girders and braced main rings of the German *LZ-129*

been the new type of train, producing net earnings sufficient to pay for itself in two years, that the Burlington is obtaining two more such trains, also electrically equipped by General Electric, for traveling the 431 miles between Chicago and St. Paul and Minneapolis in 390 minutes.

The *Zephyr* has been operated at a cost of 5152 dollars per month, or 34.21 cents per train mile; the replaced steam trains cost 9601 dollars per month, or 63.75 cents per train mile. Fuel and lubricating oil for the *Zephyr* cost 585 dollars per month, or 3.88 cents per mile, and for the steam train 2073 dollars per month, or 13.77 cents per mile. Combined maintenance-of-power expenses have been 902 dollars per month or 5.99 cents per mile for the Diesel-electric, and 2291 dollars per month or 15.21 cents per mile for the steam trains.

The Burlington system, experiencing an increase of 26 percent in passengers carried on the whole, has reported an increase of from 150 to 200 percent in the case of the *Zephyr*. The train leaves Lincoln, Nebraska, at 7:30 o'clock each morning and, 55 minutes later, arrives in the Omaha station, 55 miles away; the steam train required 75 minutes. The Omaha-Kansas City run of 195 miles is now done in 240 minutes, including a station stop at St. Joseph, Missouri; the steam train required 320 minutes. On the afternoon return trip the same speeds are maintained by the *Zephyr*.

Eckener Almost Ready

WHILE the disaster to the *Macon* has temporarily stunned the American exponents of the airship, the imperturbable Hugo Eckener is still sailing the *LZ-127* and steadily working on the *LZ-129*. Dr. Eckener was recently in the United States testifying before the Federal Aviation Commission, negotiating for a base at Lakehurst, and discussing the raising of capital for a transatlantic venture. It is doubtful whether under the present circumstances American financial co-operation is feasible, but it is quite clear that the German Government has not lost faith in the military and commercial possibilities of the airship since it announces a new large airship company to be financed mainly with Nazi official funds. The completion of the *LZ-129* has been delayed again and again, but rumor has it that its first flights will take place this spring. A first-hand description of the new craft, received from the Zeppelin Werke in Friedrichshafen, Germany, may therefore be quite timely.

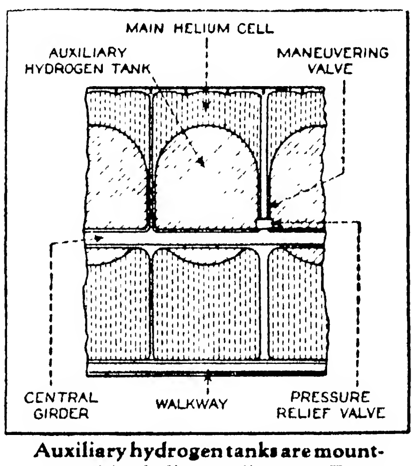
As compared with the *LZ-127* (*Graf Zeppelin*), which has visited the United States twice, the new rigid will embody many changes and improvements, and for the first time in German practice the use of helium is contemplated, at least partially.

The *LZ-129* is only a trifle longer than the *LZ-127*, but of larger diameter and greater gas capacity. The comparative dimensions of the two airships appear from the following table:

	LZ-129	*LZ-127*
Length	815 feet	770 feet
Maximum Diameter	134 feet	100 feet
Gas Capacity, cu. ft.	6,700,000	3,700,000
Horsepower	4800	2750

In the *LZ-129*, the fineness ratio—length divided by maximum diameter—is 6 to 1, and the cross-section is in the form of a regular 36-sided polygon.

The navigation compartment is placed under the hull almost at the bow. Behind the navigation quarters, in the lower part of the hull, are located the passenger quarters. Amidships we find the four engine nacelles which are located in pairs on each side of the hull. A strong keel girder runs the whole length of the ship and provides the service walkway. On each side of the walkway are located the fuel tanks, ballast and fresh water tanks, quarters for the crew, and freight and mail compartments.



Auxiliary hydrogen tanks are mounted within helium cells on *LZ-129*

The main rings are heavily braced with steel wire, and are placed at intervals of 54 or 49 feet. In between the main rings (which mark out the gas bag compartments) two unbraced rings are located. The wire bracing of the main rings is carried to a central girder. The longitudinal girders connect the 36 corners of the rings, and the rings and longitudinal girders combined serve to give the airship its outline. Duralumin is used throughout for the girder construction.

By means of the main braced rings, the hull is divided into 16 gas compartments, each of which encloses an independent gas bag. The gas bag fabric has been developed to give maximum resistance to leakage.

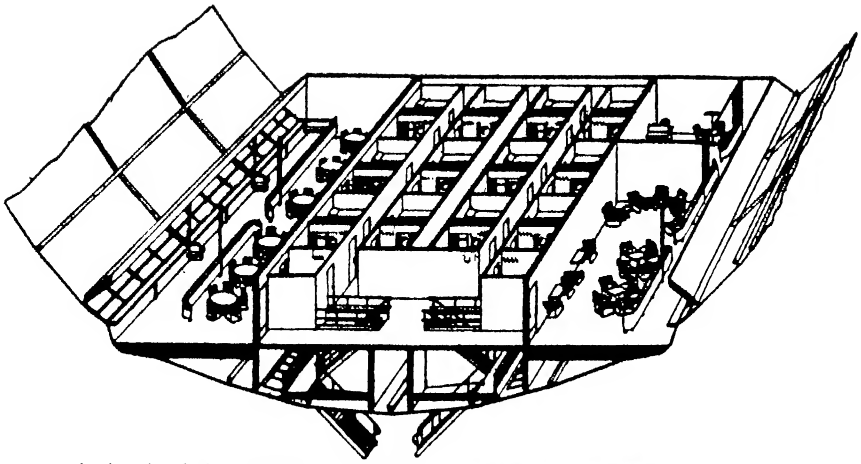
Helium has the advantage of being non-explosive, but it has 10 percent less lift than hydrogen, and is very expensive. Therefore, helium is to be used in combination with hydrogen. Within the outer helium bags there will be placed auxiliary bags filled with hydrogen, which will be entirely surrounded by the non-inflammable gas. As on a long trip, fuel is used up and the ship becomes too buoyant, the hydrogen will be released. Thus the problem of lift equilibrium will be solved without the use of the rather cumbersome and speed-reducing device of exhaust gas water recovery which is common American practice.

The power plant consists of four Diesel engines rated between 1100 and 1200 horsepower, carried in the nacelles, which are supported by struts and cables from the main hull. The speed of the ship with these engines will be 84 miles per hour. Each power "egg" will be fully equipped for engine maintenance and repair, and accessible from the keel by a special gangway. The amount of heavy fuel oil to be carried will be between 60 and 70 tons. The fuel tanks in the keel are connected by pumps with the operating fuel tanks mounted inside the engine gondolas.

The navigation unit is divided into two parts. The front part is for the actual control of the ship, with steering wheels and leads to the rudder and elevators. In the rear are the navigating quarters proper. Above the control room is the wireless cabin with provision for two-way transmission and direction finding. The various ground handling lines are in the navigation unit.

The most radical departure has been made in the design of the passenger quarters. These have been artistically designed, laid out to be thoroughly comfortable but with all unnecessary display avoided. The passenger rooms have a width of 46 feet and a length of 72 feet. Window space at the sides gives a magnificent view. For the first time in airship history passengers will be provided with a real smoking room, so fireproofed that all danger of fire is com-

Bow of the *LZ-129* in process of being covered with its outer fabric



A sketch of the arrangement of the two passenger decks on the *LZ-129*

pletely eliminated. This will be a real blessing to the great majority of the traveling public! The passenger quarters are divided into a main upper deck and a smaller lower deck. The upper deck will have on one side a dining room with promenade near the windows; on the other side are a salon, and a writing and reading room. Between the two day rooms there will be located twenty-five cabins, each with two berths. The lower deck will house auxiliary rooms, a shower bath, the ship's offices, and the smoking room. Heating will be by means of a hot water system, with a heating plant making use of the cooling water in the engine cylinders.—*A. K.*

Wiley Post's Glorious Failure

THE second attempt by Wiley Post to fly the continent in the sub-stratosphere was cut short, but it was a glorious failure. From Los Angeles to Cleveland he had covered 2044 air miles in 7 hours 19 minutes, creating an unofficial world's record. The time Mr. Post made from Los Angeles to Cleveland was much better than that made by Roscoe Turner in his transcontinental flight of 10 hours 2 minutes and 51 seconds; it took Turner 8 hours and 25 minutes to get to Cleveland.

Post's flight again drew the attention of the public, the airplane constructors, and the mail operators to the possibilities of aviation in the stratosphere or at least the sub-stratosphere, since the flight was at 30,000 feet and the stratosphere begins roughly at 38,000 feet altitude. It showed further that with an ordinary plane of 1930, the Lockheed *Winnie Mae*, whose maximum speed when built was round 150 miles an hour, double supercharging could boost the speed to 340 miles an hour. There is not the slightest doubt that this figure was attained several times on the trip.

Even though Post failed, his attempt showed wonderful care and skill in preparation. The *Winnie Mae* demonstrated remarkable qualities of strength and endurance, taking the added equipment and the added strains of supercharging without sign of any difficulty. The flight also added new laurels to Post's altitude suit and oxygen supply system which we described in October, 1934.

Some additional information of technical interest is now available:

It is apparently quite possible to remove the conventional landing gear so as to reduce air resistance, and to make a safe landing on the belly of the ship, equipped with a landing skid.

The question of lubrication at very low temperatures has been solved. The Phillips Petroleum Company provided a lubricant which functioned admirably at temperatures of 70 degrees below zero.

Another technical problem due to the cold was in the contraction of the control cables, until they were as tight as fiddle strings. To meet this situation, spring tension was introduced into the control leads.

The Westport transmitting and receiving radio set functioned perfectly under the severe conditions involved, as the world learned from the messages received during the flight.—*A. K.*

Soloing in Less than an Hour

THE Department of Commerce is reported to be busily at work on the development of an airplane in which the novice may be able to learn to fly quickly. Perhaps it is already possible to learn to fly as quickly as any one can wish in the conventional but modern plane of to-day. Thus, an air transport student of New York University, Herbert Sargent, recently made his first solo flight at the Jersey City airport after only 55 minutes of instruction. His instructor, Eddie A. Schneider, was a young man of only 23, former holder of the junior transcontinental flying record. It is true that Mr. Sargent had the benefit of an aeronautical training at the University, and also of glider experience with the student glider club of this institution. Nevertheless, the 55-minute period is highly significant. As ships improve in the normal course of events and as training methods develop, it may become possible to guarantee almost any member of the public that he or she will solo in a few hours. And even learning to drive an automobile takes a little time and trouble!—*A. K.*

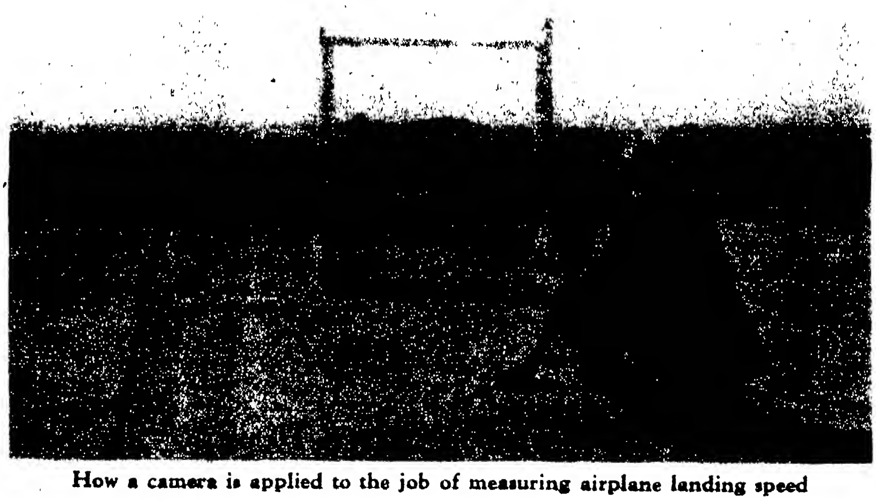
Photographing Landing Speed

IT is impossible to measure landing speeds with the ordinary air speed indicator. The pressures developed in the Pitot (the long slender tube placed ahead of the wing) are affected by the presence of the ground, and there is too much inertia in the transmission of pressure from the Pitot through the many feet of tubing leading to the indicator mounted in the pilot's cockpit. That is why landing speeds are apt to be so wildly and optimistically advertised for commercial airplanes offered to the public.

The constructors of the Boeing airliners do not sell to the general public but to the skilled operators of the airlines. Therefore they are anxious to measure landing speeds accurately. Accordingly they have devised a photographic method of obtaining this important characteristic.

The equipment consists of a 35-millimeter motion picture camera, a wire grid and an anemometer for measuring wind speed. The grid, a large wood frame with vertical and horizontal wires evenly spaced, is set up ten feet from the motion picture camera, which is carefully calibrated to determine the number of exposures per second. Cloth strips are placed 400 feet from the camera, parallel to the grid, to mark the line on which the plane must land.

As the airplane comes in for a landing, the camera is set in operation and the wind speed is simultaneously measured on the anemometer. The resultant motion picture shows the forward travel of the airplane and its angle of glide. By plotting the line of flight across the grid screen, by allowing for the ground wind as measured by the anemometer, and by taking into account the speed of the photographs and the distance



How a camera is applied to the job of measuring airplane landing speed

of the airplane from the grid, engineers can calculate accurately the actual speed of the airplane at any instant, including that of the actual landing.—*A. K.*

GASOLINE FROM COAL

GASOLINE produced by the low temperature distillation of coal is now used exclusively by nine squadrons of the Royal Air Force of England. The results have been declared generally satisfactory.

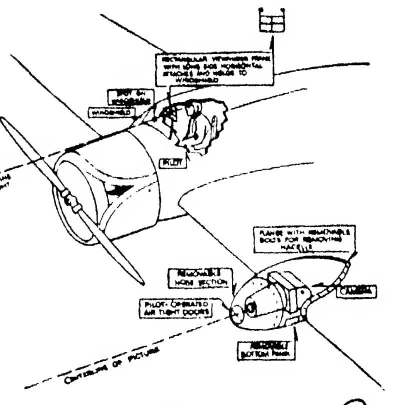
A Newspaper Office in Flight

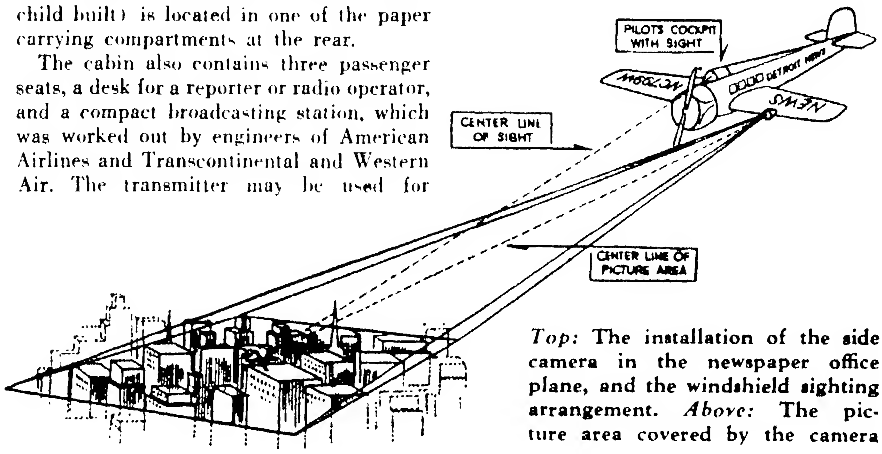
AVIATION Editor James V. Piersol of the *Detroit News* is an enterprising man who has been news gathering by air for many years. Out of his experience grew the desire to own a special newspaper-man's airplane. From his specifications the Lockheed Aircraft Corporation has built a low wing ship, on the general lines of the one piloted by Colonel Lindbergh in his last transatlantic expedition. The plane itself, efficient and well designed as it is, offers little of special interest. Perhaps the one noteworthy point in the design is a reversion to wood, instead of the metal which has become customary in modern practice, to minimize camera vibration and background noises deterrent to broadcasting. The *Detroit News'* plane is equipped with the Sperry Automatic Pilot and a Pratt and Whitney Hornet engine. But the real interest lies in the camera and cabin installation, and in the radio equipment which includes a new transmitter to be used as an auxiliary of station WWJ.

Three camera installations make it possible to take pictures at any angle from the plane—forward, above, or below. One camera is mounted in the left wing, eight feet from the fuselage. It is installed in a fixed position parallel to the line of flight and is enclosed in a neatly streamlined nacelle. The camera is operated by an electric motor with controls leading through the wing to the pilot's seat.

A gun sight mounted on the pilot's windshield serves as the pilot's view-finder. He aims the airplane and thus automatically aims the camera. Once in position, the pilot presses a trigger on his control stick to take the pictures. Photographs can be taken at intervals of two seconds and a total of 110 can be taken with one loading of the camera magazine. Photos can also be taken straight down from the plane through the floor of the cabin, and this installation can be operated either manually by the passengers or automatically from the pilot's seat. The third camera installation (all are Fairchild built) is located in one of the paper carrying compartments at the rear.

The cabin also contains three passenger seats, a desk for a reporter or radio operator, and a compact broadcasting station, which was worked out by engineers of American Airlines and Transcontinental and Western Air. The transmitter may be used for either voice or code and can also be operated either from the pilot's seat or from the passenger cabin.—*A. K.*





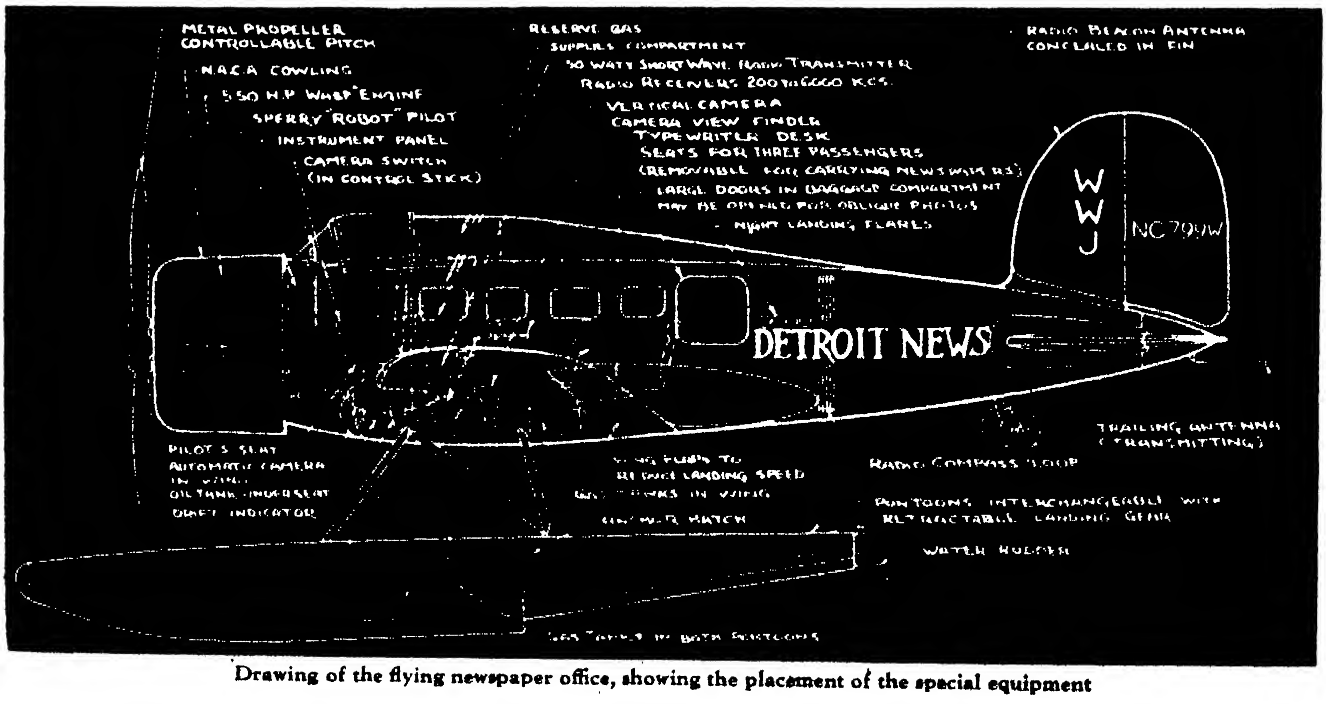
Top: **The installation of the side camera in the newspaper office plane, and the windshield sighting arrangement.** ***Above:*** **The picture area covered by the camera**

Report of the N.A.C.A.

EVERY year the National Advisory Committee for Aeronautics transmits to the Congress of the United States a message or summary accompanying its full report. This message is always of particular interest because it reviews aeronautical research and development in a broad and authoritative way. The Twentieth Annual Report is no exception to this rule, as the following brief extracts will show.

"As aerodynamic efficiency increases with the size of airplanes, the trend of development probably will be toward larger aircraft of greater range and weight-carrying capacity. Larger aircraft can be made adaptable to simplified internal bracing and structural refinements, so that cost of construction need not increase proportionately with size." We may cite the construction of the Pan-American Clippers in support of this view.

"For certain types of large airplanes, engines of larger horsepower are desirable, and a number of promising developments are now under way in this country." We may state that a Prestone cooled engine of around 1100 horsepower is being developed very successfully. For very large engines the drift is away from air-cooling back to



Drawing of the flying newspaper office, showing the placement of the special equipment

liquid cooling, because the cooling of radial engines of high capacity seems to offer increasing difficulty.

"With the development of large airplanes and large liquid-cooled engines, there will come a need to house the engines entirely inside the wings. This consideration will call for different types—different shapes—of engines." It is an open secret that the large liquid-cooled engine now in process of construction will have a very long propeller shaft, so that the engine may be housed inside the wing, with the propeller at the leading edge of the wing.

The Committee's laboratories at Langley Field are perhaps the most completely equipped aeronautical laboratories anywhere in the world. With the aid of P.W.A. funds some extremely valuable and interesting new apparatus is being added to these laboratories, some of which is mentioned in the following paragraphs.

"Refinements in design, reduction in drag, and increased engine power will make possible greater speed. The 500 mile per hour wind tunnel to be added to the research equipment should provide important new knowledge on problems of flutter, vibration, and the forces acting on aircraft structures, and thus make possible the use of the highest speeds with relative safety. . . . A 24-inch high velocity jet-type wind tunnel . . . will be used primarily to study air flow over propeller tips at speeds approaching the velocity of sound in air, with a view to improving the aerodynamic characteristics of propeller tips."

Altogether, a very encouraging picture of American progress is given by this excellent message.—*A. K.*

The Direct Take-Off Autogiro

SENOR Juan de la Cierva has been working on his Autogiro for over 20 years, yet every year sees some definite advance due to his tireless and fertile engineering imagination. His latest improvement, announced in a lecture before the Royal Aeronautical Society, is that of the direct take-off 'giro which accomplishes at least partially one of the long-sought-for objectives of the helicopter.

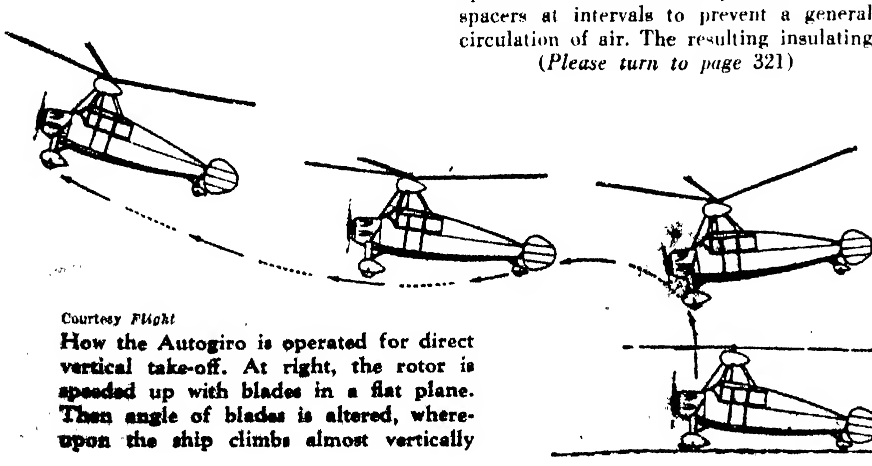
While exact details of the mechanism involved were withheld in the lecture, it is possible by careful interpretation to arrive at a reasonable understanding of the new principle.

We know that the Autogiro is now equipped with a mechanical starting system whereby the blades are brought up to autorotative speed much more quickly than by the old process of running the machine up and down a field. Now let us suppose that, prior to take-off, the blades are set to a small angle of incidence; that is, the blades lie flatly in their plane of rotation. The drag of the blades is then reduced to a minimum and the starter can raise their speed of rotation far above that of normal. Next suppose that the starter system is declutched, and that simultaneously the blades are returned to their normal angle of incidence, with the forward propeller given the full power of the engine. The inertia of the blade system will then carry then 'round for a short time at "over-speed." The coning and the lifting power of the blades will then evidently be far above the normal.

With the lift in excess of the weight of the machine, the Autogiro will immediately leave the ground on a steep, almost vertical path. When the machine is some 60 or 70 feet off the ground, the "over-speed" of the blades is gone, the excess lift disappears and the path of the machine is likely to be downwards. But by this time the thrust of the forward propeller has given the aircraft the necessary forward speed so that the drop is not pronounced and hence normal climbing is soon attained.

The whole process is illustrated schematically in the diagram and has decided possibilities for taking off from restricted territory, ploughed fields, or even the roofs of buildings.

Rumor has it that the method for changing the angle of incidence of the blades is one of extreme simplicity. The blades of the Autogiro are hinged about a horizontal axis, but also have a vertical axis mounting. The motion about the vertical axis is strongly damped by a rubber mounting. Now, if we imagine the vertical pin to be inclined slightly outwards, then if the starter is at work and the blades lag behind, it will be seen that their angle of incidence will tend to diminish. This is precisely what is required for the process of direct take-off. Therefore substantially no changes in design were required to achieve this remarkable step forward.—*A. K.*



Courtesy *Flight*

How the Autogiro is operated for direct vertical take-off. At right, the rotor is speeded up with blades in a flat plane. Then angle of blades is altered, whereupon the ship climbs almost vertically

Iron Insulation

A RECENT development in heat insulation consists of parallel plates of black sheet iron, creased into angularly arranged surfaces, with small ribs at the junctures of these surfaces. This insulation, known as Ferro Therm, makes use of several sheets of the formed metal installed at distances apart best suited to the requirements, with spacers at intervals to prevent a general circulation of air. The resulting insulating

(*Please turn to page* 321)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

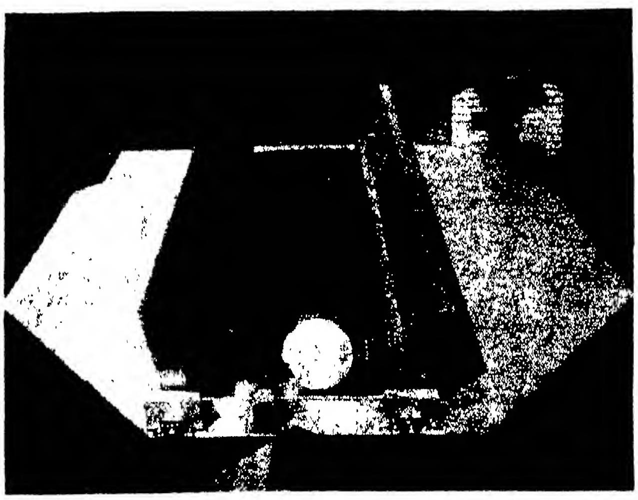
JAMES STOKLEY, Associate Director of the Franklin Institute Museum and Director of the Fels Planetarium at that institution in Philadelphia, at our request, has prepared the following description of the new horizontal refractor owned by Gustavus Wynne Cook of Wynnewood, a Philadelphia suburb. Mr. Stokley has used this and the other astronomical equipment at Mr. Cook's observatory, and thus writes from considerable first-hand knowledge. He says:

Photos by E. N. Fought, M.D.

The Cook telescope housing. *Left:* Siderostat house. *Center:* Tube. *Right:* Observing room

"Protection against temperature effects is not necessary to those who use a new telescope at the Roslyn House Observatory, Wynnewood, Pennsylvania. This unique institution, the private observatory of Mr. Gustavus Wynne Cook, Philadelphia banker and manufacturer, has been described in previous articles in SCIENTIFIC AMERICAN (August 1932, p. 74; January 1934, p. 17). To own a well-equipped 28½-inch reflecting telescope, provided with a large spectograph so that it is used regularly on a research program for measuring the radial velocities of the stars—not to mention the 40-foot focal length sun camera, the spectroheliosocope, the astronomical transit instrument, a 7-inch aperture and meridian circle and other items that would be creditable in any college observatory—might satisfy many persons. But Mr. Cook is not happy unless he is putting up a new telescope, and the latest addition has now been in use only a few months. With it he sits in a nicely furnished, and heated, room. At one end is an assortment of dials that reminds one of the control room of a submarine, and an eyepiece tube that might represent the end of a periscope. Without moving his head, the observer can press buttons and view almost any part of the sky. The dials automatically show exactly the position of the region at which he is looking.

"This is the latest form of siderostat telescope. Such instruments are not new in principle, as the first was designed by the French astronomer Léon Foucault, who died in 1868, and a huge one was displayed at the Paris Exposition in 1900. But now, probably for the first time, such a telescope has been constructed which makes full use of modern electrical equipment so that the operation is not as much trouble as driving an automobile. The flat mirror is mounted in a vertical fork, so that it can turn freely around either a vertical or a horizontal axis. Attached to the back of the mirror, projecting out at right angles to its plane, is a rod. The driving mechanism is placed immediately to the north, and is equipped with a polar axis which turns once in 24 hours. Attached to this is an arm which moves north and south, and at the end of this arm is a sleeve on which slides the rod attached to the mirror. This mechanism is shown in one of the photographs. By means of it, the mirror is automatically moved at exactly the right speed for each declination. The instrument is adjusted in declination by moving the arm attached to the polar axis. The tube of such telescopes is usually placed to the south of the mirror, so that the eastern and western halves of the sky may be reached with equal ease.

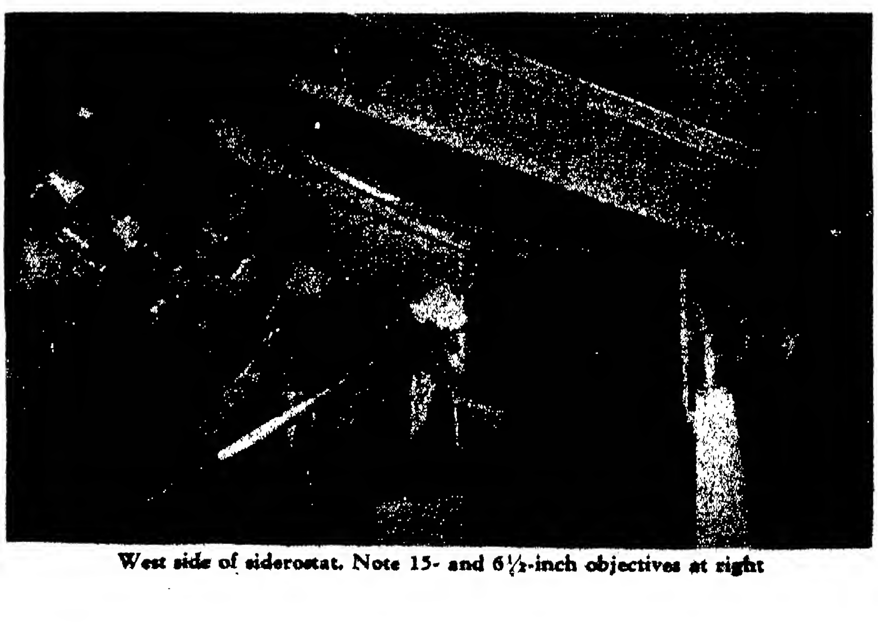


Revolving roof of the siderostat house, showing also the polar axis and the 26-inch Pyrex flat of the siderostat

"The objective of the Roslyn House instrument is of 15 inches aperture and 225 inches focal length. It was made in 1907 by John A. Brashear, and remained unused until purchased by Mr. Cook. It was tested by J. W. Fecker, of Pittsburgh, successor to the Brashear firm, who pronounced it excellent.

"Mr. Cook was undecided as to how he should mount this objective. The conventional mounting, with the dome, would have been as large as a two-story house, and out of keeping with the residence and other buildings nearby, in addition to lacking the advantages of a warm observing room. A polar telescope would have required the erection of a somewhat unsightly tower, so a horizontal telescope was definitely indicated.

"Accordingly, Mr. Fecker was given the contract for the instrument, and the buildings were designed by Mr. Cook and built under his direction. The Pyrex glass plane mirror, 25 inches diameter, the driving mechanism, and the lens, are mounted on concrete piers in a small square building, provided with a circular, rotating roof, in which a wide slit can be opened to expose the mirror to the sky. At present the mirror is coated with silver, but equipment is being built to give it an aluminum surface. The tube of the telescope extends to the south, across a short open stretch and into the other building which, in turn, connects with the transit room, a clock room, and the room for the 28½-inch reflector. The observing room is heated from a heating plant some yards away. The breech of the telescope, and the various dials, are mounted on a third concrete pier to give the



West side of siderostat. Note 15- and 6½-inch objectives at right

greatest possible stability against vibration.

"A total of 12 motors is used in the operation of the instrument. One is a synchronous motor for the main drive of the polar axis. Two motors are used for the motions in right ascension and declination, the same motors serving for the fast and slow motions by shifting an electrically operated clutch. A motor-generator supplies direct current to operate the numerous relays. A second synchronous motor turns the eyepiece, when used for photography, as there is a rotation of the image, and a third operates a dial to show sidereal time so that the instrument can be set directly to a star's R. A. without stopping to figure out the hour angle, which is normally necessary. A pair of Selsyn motors connects this dial with the polar axis, and another pair connects another dial with the declination axis. Selsyn motors are "self-sychronizing," and when two are connected to the same power source the shaft of one turns in exact step with that of the other, as if they were mechanically coupled, even though miles of wire might intervene between them. Other motors operate an iris diaphragm over the lens, and the rotating roof.

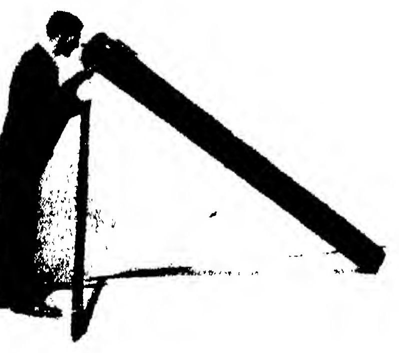
The observing and control panel. *Left, top:* Eyepiece end of the 6½" finder and guide telescope. *Right, top:* Eyepiece end of main telescope. *Left, bottom:* R. A. circle. *Right, bottom:* Declination circle. A smaller circle hidden behind eyepiece of main telescope indicates position of revolving roof

"Mr. Cook intends to use the instrument to a great extent for photography, and the support of the objective is now being slightly modified to simplify the attachment of the photographic compensating lens, which shortens the focal length. Guiding for photography may be done in two ways, one by using a double-slide plateholder, with two eyepieces on each side of the plate, through which stars just out of the field being photographed are kept in view on cross hairs. The other way is with a separate 6½-inch lens (see photograph), of the same focal length as the large objective, which is fed by a small flat mirror, attached to the side of the big one, and moving with it. This lens supplies a separate eyepiece, at the left on the observing panel. With this, however, the rotation of the image cannot be checked, as with the guiding stars on each side of the plate.

"The telescope cannot reach the pole, but can come within about 20 degrees of it, and thus can reach the most interesting parts

of the sky. Mr. Cook points out that it has one advantage over a polar telescope, for when such an instrument is directed to the southern sky, the plane mirror is used at a grazing angle, the least desirable position, as this emphasizes any of its defects. With the siderostat instrument, on the other hand, the light from an object in the south is reflected back almost at right angles to the surface.

"For comfort in use, and easy, convenient



A centenarian Herschelian telescope, made in the U.S.A., 1835

operation, the new Roslyn House telescope is to be commended, as anyone who has had experience with it, also with usual types of telescopes, can amply testify. But the fixed eyepiece has other advantages beside mere comfort for the observer. There are many problems of astronomy, such as the measurement of star brightness with photoelectric cells, where a considerable amount of delicately adjusted apparatus must be attached to the telescope. When this also has to swing around at all sorts of angles, the mechanical problem is a difficult one. At Roslyn House, a whole roomful of apparatus might be placed at the focus, and left there as long as needed. In fact, it is so effective that it will be rather surprising to the writer if, as it becomes better known, it is not duplicated again and again."

THUS ends Mr. Stokley's description. Mr. Cook, however fortunate in having so much fine equipment, is not reserving it for his own pleasure, but has also invited in and is maintaining two professional astronomers, Dr. Orren J. Mohler and Mr. I. M. Levitt, in order to keep it in steady use for routine scientific programs in connection with astronomy as a whole.

In his description Mr. Stokley refers to a siderostat, and so this is a good time to harp a bit on siderostats, coelostats, and heliostats—just precisely what are they? For years we have tried to find out. Few persons know *just* what each of these three is, though it is easy to jump at conclusions or discover that one really doesn't know. We once asked a professional to tell us. He started off in high gear, and then choked and discovered he didn't know *just* what each of the three was. The dictionary is as clear as mud about them. The other day, however, we blundered across the following, from an article in *Astrophysical Journal*, March 1900, by M. A. Cornu of Paris. Can anybody find any flaws in these? A *siderostat*, Cornu says, is especially constructed to send a reflected beam toward the southern horizon; a *coelostat* (we don't want to seem high-brow, but that word is pretty often mispronounced. It's seé-lo-stat) has a mirror that turns about an axis parallel to the earth's axis with an angular velocity half that of the diurnal revolution in the same direction; a *heliostat* sends the reflected beam in the direction of the northern horizon, rarely beyond NE or NW.

THE slanting telescope shown on this page is an old Herschelian now at the Smithsonian Institution, U. S. National Museum, Washington, D. C., and the following comment was sent in by Frank A. Taylor, Division of Engineering, that institution:

"The telescope illustrated is a professional job of 1835. It was made by Amasa Holcomb(e) of Southwick, Mass., who was probably the first man in the United States to make telescopes in any number for sale to astronomers. This telescope was recently presented to the United States National Museum at Washington by his descendents.

"Holcomb began the construction of instruments for students whom he instructed in astronomy and surveying about 1820. From the manufacture of small refracting telescopes he progressed to the construction of reflectors on the pattern of Sir William Herschel, only a few of which had been seen in the United States at that time. About 1833 Holcomb took two of his telescopes to Philadelphia, where they were examined by a committee of the Franklin Institute, which was very favorably impressed with their performance.

"The instrument at the Museum has a 9-inch Russia iron tube approximately 9 feet long, closed at the lower end with a slip-on cover within which is attached a tin-alloy speculum. On the inside of the upper end is a roughly-made rack which carries the eyepiece and which meshes with a small pinion attached to a focusing knob on the outside of the telescope. The lower end of the tube is supported on a brass bar which terminates in a spike at one end and a wheel at the other, designed to permit the tube to pivot easily about the spike as a center. The upper end of the tube is supported on a simple bipod [Similar bipod mounting in SCIENTIFIC AMERICAN, Apr., 1933, p. 241.—*Ed.*], each limb of which is readily adjustable by means of a cord wound about a winch and running through small blocks in combination with the two sliding parts of each limb. By working the two small winches properly, the upper end of the tube can be made to describe practically any motion required in sighting or following a star."

The speculum of the telescope is in good condition, and it has been used with some success since it was presented to the Museum.

TYPICAL of the wide variety of occupations represented by the followers of the amateur telescope making hobby is a compilation sent us by Leo. J. Scanlon of Pittsburgh, at our request, showing a cross-section of the membership of the Astronomical Section of the Academy of Science and Art of Pittsburgh, essentially a club of amateur telescope makers.

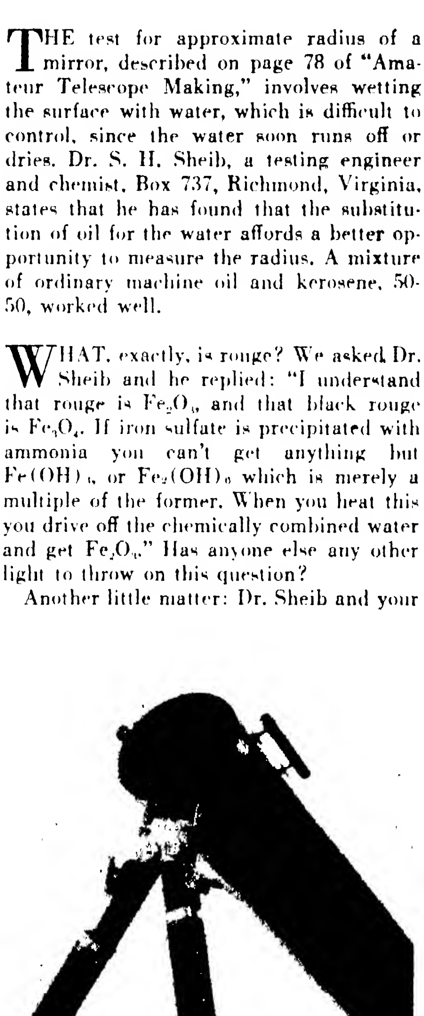
In this club are: electrical engineers 7, Westinghouse employees 8, electrical installation repairmen 2, cigar rollers 1, chemists 6, insurance salesmen 2, millwrights 3, clerks 11, sales executives 5, high school students 14, restaurant managers 2, salesmen 6, news photographers 1, stenographers 2, community house executives 2, draughtsmen 6, radio technicians 2, attorneys 1, vice-presidents of railroad 1, railroad engineers 3, baggagemen on railroad 1, grocerymen 1, news editorial writers 1, printers 2, chauffeurs 1, physicians 4, physicists 2, science teachers 1, commercial photographers 2, electricians 1, dentists 2, skilled mechanics 7, sign painters 1, Boy Scout executives 1, welders 1, research workers (Gulf) 2, projection machine operators 1, plumbers 1, college students 2, machinists 2, farm wives 1, refrigerating engineers 1, machine designers 1, credit men 1, editors farm journal 1, nuns 2.

So this is what amateur telescope makers are made of. A pretty solid cross-section of America, is it not?

THE test for approximate radius of a mirror, described on page 78 of "Amateur Telescope Making," involves wetting the surface with water, which is difficult to control, since the water soon runs off or dries. Dr. S. H. Sheib, a testing engineer and chemist, Box 737, Richmond, Virginia, states that he has found that the substitution of oil for the water affords a better opportunity to measure the radius. A mixture of ordinary machine oil and kerosene, 50-50, worked well.

WHAT, exactly, is rouge? We asked Dr. Sheib and he replied: "I understand that rouge is Fe_2O_3, and that black rouge is Fe_3O_4. If iron sulfate is precipitated with ammonia you can't get anything but $Fe(OH)_3$, or $Fe_2(OH)_6$ which is merely a multiple of the former. When you heat this you drive off the chemically combined water and get Fe_2O_3." Has anyone else any other light to throw on this question?

Another little matter: Dr. Sheib and your



Detail of the Holcomb Herschelian

scribe have been trying to work out the depth—not the diameter but the depth—of pits for different abrasives. Is any amateur equipped with a microscope having a vertical illuminator and micrometer, who can and will help us measure, if possible, the distance to their bottoms, possibly by focusing on them and using the flat surface as datum; that is, focusing the flat surface and making a reading, and then focusing the bottom and making another reading. This is theoretical and maybe it won't work. Good quantitative data on depths of pits for each size of abrasive ought to provide a basis for working out optimum grinding time for each stage of abrasive. Is depth strictly proportional to grains?

THE SCIENTIFIC AMERICAN DIGEST

(Continued from page 317)

effect, it is stated, is better than that of cork, while the material is said to be less costly than any other standard insulating material.

Ferro Therm depends for its efficiency on the high reflectivity of black iron for energy frequencies in the radiant heat range. The new insulation is applied to both flat and cylindrical surfaces and is said to be well suited for uses ranging from cold storage rooms to boilers and steam pipes and other high temperature applications where insulation is required.—*A. E. B.*

50,000 PLANETS

SPACE is filled with cosmic dust but how many of these particles of dust are large enough to be called planets? Professor A. O. Leuschner, University of California, estimates that in our small solar system there are about 50,000 so-called minor planets within reach of the largest telescopes.

AND NOW, HEAVY OXYGEN ALSO

JUST before going to press with the present number containing Professor Urey's article on heavy hydrogen, the following *Science Service* report reached the editor:

What is probably the world's rarest liquid, "heavy oxygen water," is now being produced at Manchester University, England, by means of a recently constructed diffusion apparatus.

Only a few drops of the heavy oxygen water exist. The new apparatus in which Lecturer J. B. M. Herbert and Prof. M. Polanyi of Manchester University demonstrated the production of heavy oxygen water is designed to produce 0.02 gram of the water per day.

One atom out of every hundred of the oxygen atoms in heavy oxygen water has a mass of 18 instead of the usual mass 16 of ordinary oxygen. In ordinary water the normal proportion is about one in 500. Scientists consider this concentration of the heaviest oxygen as a real achievement, since the difficulties are much greater than in separating the famous three kinds of hydrogen recently discovered.

Prof. G. Hertz of Berlin made the world's first sample of heavy oxygen water and presented the precious 10 drops (half a gram) to Prof. Polanyi, who was formerly professor of physical chemistry at the Kaiser Wilhelm Institute in Berlin. The isotopes or atom varieties of neon, the gas now used in electric signs, were also separated by Prof. Hertz.

The Manchester University apparatus for producing heavy oxygen water is very complex and consists of nine mercury vapor diffusion pumps circulating gas through porous clay called steatite. The very slight

difference in weight between the light and heavy oxygens in the water vapor makes the concentrating process slow and tedious. Even compared with its use upon gases like neon, the process is slow because the water vapor condenses upon the surfaces of the clay tubes.

Prof. Polanyi is at present in Moscow where he is consulting with Soviet scientists engaged in similar work.

CAVIAR FOR RICKETS

A REPORT from Russia reminds us of Marie Antoinette's "Then let them eat cake." In that country experiments have recently been carried out in feeding caviar to babies to prevent rickets, since caviar is rich in vitamin D.

Makes Paint Stick to Steel

A PROCESS for "conditioning" steel that is designed to promote paint adhesion and also to improve the rust resistance of the material, involves the use of a new crystalline material known as Cromodine. *Solvent News* reports that an excellent finish for high bake enamels, synthetic materials, and oil primers is obtained.

The process consists of first removing oil and rust from the steel surface in any approved manner and then dipping the parts into a heated solution of the Cromodine. The solution is held in a stainless steel tank and is heated by steam coils to 170 to 180 degrees, Fahrenheit.

The immersion lasts for one minute, following which the parts are rinsed in cold and then hot water and dried. When wiped of a powdery residue left by the process the surface is ready for the prime paint coat. The cost of the process is estimated at approximately ten cents per 100 square feet of surface to be treated.—*A. E. B.*

Springs of Quartz

TO measure the amount of moisture taken up by paper samples from an atmosphere of a certain exact humidity is a delicate weighing job that must be done without breaking into the humidity chamber and upsetting the whole object of the test. The best way is to keep a continuous weighing device at work in the chamber, and scientists have found that under the given conditions a coil spring of pure quartz is the best device for fine and dependable weighing. A quartz spring does not rust or corrode, and it always comes back just to the mark when the load is taken off. Tests show that loading for two years or more causes no permanent sag. For a substance that looks like glass, the quartz filament is remarkably tough.

Forest Products Laboratory workers now make their own quartz springs for determining moisture characteristics of the new papers they are developing from American woods. A quartz rod is heated in an oxygen blowpipe flame and is pulled out into a long thread. This thread is then coiled, under less severe heat, into a spring about 6 inches in length, and a hook is formed at each end. After its stretch under standard known loadings has been carefully determined, the spring is ready for business. It is suspended, carrying its sample scrap of paper, inside a window of the humidity chamber, and its lengthenings and shortenings with changing moisture in the sample are accurately read by means of a cathetometer telescope mounted outside. Springs in use at the Laboratory are so sensitive that a change in weight of four one-millionths of an ounce can be easily measured.

Metal Radio Tubes

A NEW line of metal radio tubes, which tests indicate to be of greater continued efficiency of operation than the glass type now in use, was announced recently by the General Electric Company. Developed in the research laboratories of the company at Schenectady, these new metal tubes are not only much smaller and more sturdy, but are stated to offer improved electrical characteristics over the conventional tubes of today. They provide their own shielding and this metal shell is a better heat conductor and radiator than glass. They are particularly advantageous in the field of short wave reception. The short leads of the tubes permit greater amplification at the higher frequencies and the more effective shielding insures greater stability.

These new tubes are not interchangeable with glass tubes in the present type radio

Above: One of the new metal radio tubes, and another cut away to show elements. _Below:_ Glass tubes and their equivalents in metal; also, a "duo-diode" made only in metal

receivers and will later make their first appearance in a new line of sets.

In the metal tubes, each lead-in wire passes through a tiny bead of special glass that is fused securely within an alloy eyelet, which in turn is welded to the metal container, thus assuring a long life vacuum. This alloy, having substantially the same coefficient of expansion as glass, is known as Fernico and is a combination of iron, nickel and cobalt.

The familiar metal shield which is necessary with the glass tube in radio-frequency portions of a circuit is no longer required with the new tube. The metal envelope itself serves as a shield, and, since closer proximity of shield to elements can be realized, the shielding is more effective. The new tubes have one more base pin than comparable glass tubes, in order to make provision for grounding the metal envelope.

ART

PAN-American Day, celebrated this year on April 15, was marked by the signing by representatives of 13 American republics of a treaty to protect art galleries and scientific museums in time of war. For humanity's sake, such institutions are, in effect, declared neutral territory and safe from attack.

METALLIZED PAPER

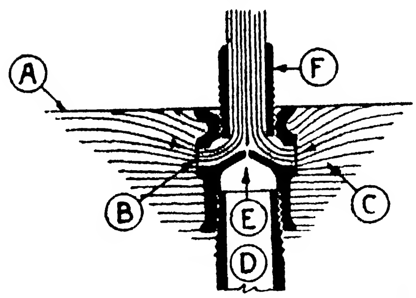
AMONG the recently developed packaging papers, DuPont announces the production of a metallized paper for labels, wraps, and inside liners. In this paper, the metal coating is deposited directly on any of a wide variety of paper stocks, providing a smooth, high-luster metallic finish resembling foil. Because the finish is applied directly to the paper, there is no lamination or possibility of peeling. The color is chromium-like. It will take printing and lithographing, as long as the inks used are suitable to the surface, which will not permit penetration. The paper can also be die-stamped or embossed.

When used as a wrap, this metallized paper can be cemented to itself with commercial types of adhesives. The finish resists oils, greases, water, humidity, tarnish, and corrosion, protecting the contents of the package or container. The product is available in continuous rolls up to 40 inches in width, and in sheets of even greater length. —*A. E. B.*

INGENIOUS GARDEN FOUNTAIN

MANY people would enjoy the play of fountains on their lawns were it not for the fact that they would have to use costly city water or install equally costly pumping equipment. An ingenious new fountain device which uses the steam injector principle commonly employed in boiler plants for keeping the boiler full has been invented by Mr. C. H. Andrews of New Castle, Pennsylvania. This fountain utilizes the fountain water for the large spray effect that is obtained, the power being obtained from the city water main. A

Above: **Garden fountain in operation.** ***Below.*** **Sketch of fountain mechanism. A, water level in pool. B and C, water inlets. D, water from main. E, pin hole opening from city main. F, sleeve regulating the flow**



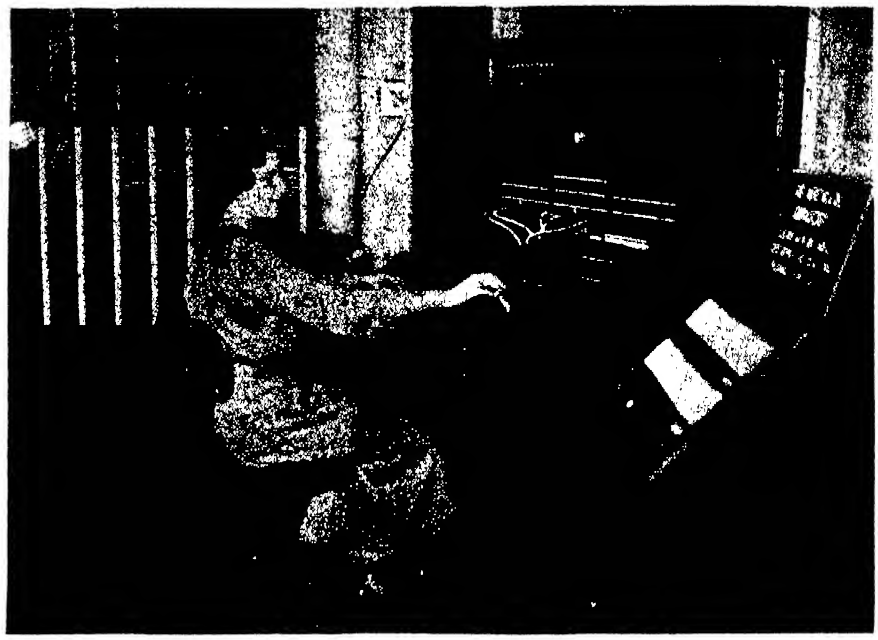
tiny stream shooting at high pressure through the central orifice of the fountain draws with it a large volume of water from the fountain through annular openings. As can be seen from the illustration the device is extremely simple and is said to be inexpensive to operate.

THE LUMINOUS WOMAN OF PIRANO

CERTAIN animals and plants are well known to give off phosphorescent light, and from time to time luminous human beings have been reported. Generally, but not always, this emission of light has been noticed just before death. Little is known of the cause of this luminosity, and curiosity has been quickened by Anna Monaro, the Luminous Woman of Pirano, of whom Dr. G. Protti, of Venice, has recently published an account.

Dr. Protti first collected the evidence of eye-witnesses. The usual time of the light's appearance was during the early part of the night, never in the daytime, or when Monaro was only lightly asleep; it lasted never longer than three to four seconds, it always appeared in the region of the heart, it varied in color from green to red. Monaro herself was unaware of the light and it left no trace of odor, heat, or color.

Dr. Protti next made his own examination and found Monaro normal in every way, except that she suffers from asthma and has slightly raised blood pressure. She lives almost in indigence, but such food as she eats is in no way out of the ordinary. During Lent she fasts strictly, eating only soup and milk, and at this time the phenomenon manifests itself most frequently, particularly during Holy Week when the fast is almost absolute. In one night the light appeared 25 times.



No, the young lady is not playing a pipe organ, nor is she operating a telephone switchboard. She is demonstrating a model factory production control system introduced by Remington Rand. By means of this, it is possible for one girl to keep accurate records which now require the work of scores of time-keepers and clerks. At right is the automatic punch which produces the basic record

Convinced that the appearance of the light was not the result of collective hallucination, Dr. Protti installed a powerful cinematograph with a supersensitive film on which an automatic registration of the duration of the light could be made. Above the region of the heart he suspended a photoelectric cell connected with a sensitive galvanometer, and in order to eliminate all possibility of electricity being used he arranged an electroscope enabling him to examine the state of the electric charge of the air around the patient. The bed was insulated from the floor.

With the room in complete darkness a light was seen after a time to emerge from the bedclothes and Dr. Protti immediately started the cinematograph at 16 exposures per second. The light lasted 3 3/16 seconds and gradually faded away. It illuminated the jaw and cheek bones, but caused little shadow contrast. It arose from the region of the heart from an area the size of an adult's open hand, and was sufficiently strong to make the adjacent beds visible. No current was registered on the galvanometer, and when the observation was controlled there was no appreciable change on the electroscope. However, a definite shadow appeared on the cinema film. Monaro, whose sleep is usually broken and disturbed, woke with a start. At the time the light appears the heart accelerates to about double the usual rate.

An estimation of the radiating property of the patient's blood showed this to be three times that of normal blood, and it is considered that this is significant in connection with the origin of the light. This property is said to vary with the basal metabolic rate.

Having, as he believes, excluded trickery and the taking of phosphorus, Dr. Protti suggests that the religious complex which dominates the patient disturbs the endocrines, upsets the vago-sympathetic balance, and induces certain salts of the blood, notably sulfur compounds, to become phosphorescent. Such a change, he thinks, is facilitated by the fasting state. More recently Dr. G. W. Crile is reported to have demonstrated at Cleveland the emission of both visible and infra-red waves from the brains of dogs, the radiation being increased by thyroxine and adrenalin and decreased by anesthetics. Alcohol first increased and then diminished the radiation.—*The Lancet* (London).

PURE NICKEL

ETHIOPIA is now the 28th country to coin pure nickel as that country has just put into circulation 10,000,000 nickel coins of the 25 *roul* denomination and 5,000,000 of the *alati* denomination. Contrary to popular belief, America with its five-cent piece is not one of the 28 countries as this coin contains 75 percent copper.

CHEMICAL FLY-"SWATTERS"

"SWAT the fly!" is coming more and more to imply the use of chemical sprays, the efficacy of which is being constantly improved by experiment. Recently it has been found that certain synthetic organic substances such as santalyl acetate, the dialkyl phthalates and butyl-salicylate are repellent to certain species of flies, including the housefly, although they are odorless to human beings.

Two plants, derris and pyrethrum, are the noxious constituents in most fly-killing sprays. The former is to some extent replacing the latter, because a kerosene extract of derris provides a slow but distinct killing action extending and increasing over a period of 48 to 72 hours. Derris will give a larger amount of effective kerosene

extract than pyrethrum. Pyrethrum extracts provide great paralyzing and some killing action; derris extracts excel in killing action. Large quantities of derris and pyrethrum products have been used this past season for the control of truck crop pests, such as the cabbage worm on cabbage and cauliflower, replacing arsenical insecticides. Derris has also shown promise for controlling the squash-vine borer moth, as well as the cherry fruit fly. Pyrethrum is apparently a specific poison for the celery leaf tier worms.—*A. E. B.*

COBRA VENOM

THE pain of inoperable cancer is said to have been relieved by injections of suitable doses of cobra venom. Dr. David I. Macht, of Baltimore, in reporting this says that the pain-relieving effect is due to the venom's action on nerve centers in the brain. Of course, no curative effect is claimed.

Beauty in Concrete Houses

NATIONAL interest in pre-fabricated housing—the newest development in the home building industry—has centered attention on the first house to be built with pre-fabricated walls of Earley mosaic concrete, erected on the Colesville Pike, just north of Washington, D. C.

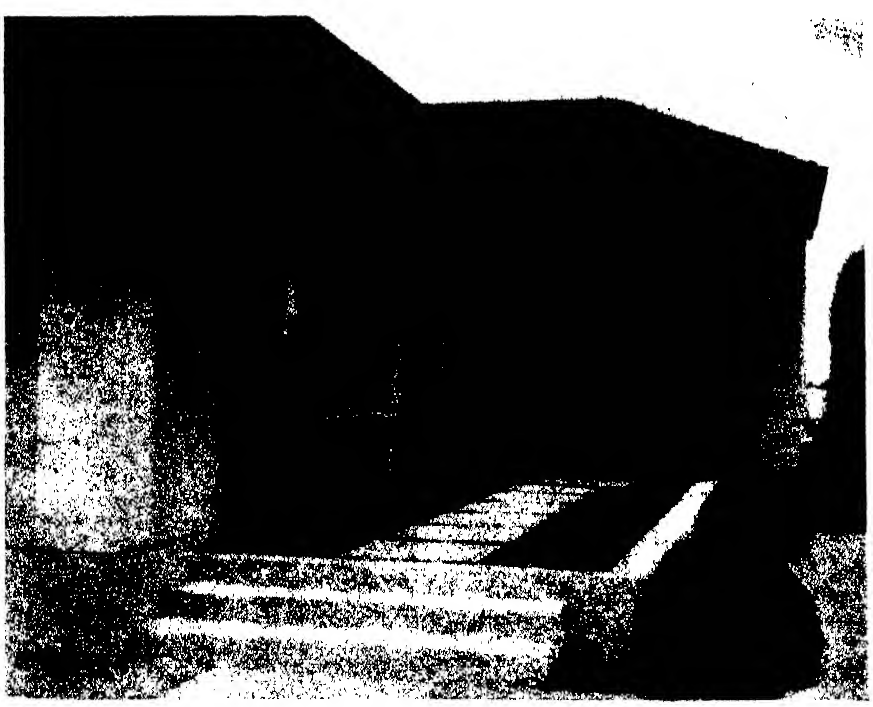
This house is the work of the studios of John J. Earley. It is built of 32 panels, each nine feet high and varying in width from four to eight feet. The panels are made of two-inch reinforced concrete with a surface of exposed aggregates of red jasperite from Oklahoma, which gives the slabs the appearance of granite and makes them a new triumph of beauty in concrete.

Since the slabs are pre-cast, it is possible to manufacture them under studio conditions and to harden them to a point where they are absorption-proof and water-tight. Window casements are cast into the slabs during the course of pre-fabrication, thereby avoiding the possibility of leakage and assuring proper alignment.

By a patented process, the slabs are made, face downward, in carefully designed molds carved by expert craftsmen to give the castings a perfectly chiseled surface. The mosaic frieze and the other mosaic decorations of the slabs are achieved by putting on the plaster forms of the mold a minute ridge about one-eighth of an inch high to mark the lines between the various colors of the design. The mosaic particles of the colored design, carefully prepared in a mixture of colored stone, and sand crushed from the same stone, together with cement and water, are then placed into their proper position in this design. After the reinforcing mesh has also been put into position, the mold is filled to a depth of two inches with quartz concrete of the same mixture as the colored concrete in the surface.

Only the hardest of stone and stone-like materials are used to form the pre-cast slabs. No pigments are used. The aggregates are

Above: **Steel window casement cast in pre-fabricated concrete slab for the finely textured concrete house shown below. See text on this page**



crushed in the studio, the largest flakes being roughly one-half inch in diameter and the sand particles—crushed from the same material—are graded, as are the larger particles, to a pre-determined formula which requires that this be done with an exactness of 1/1000th of an inch. All dust is eliminated in this process.

Because it is important that the concrete should fill even the tiniest and sharpest crevice in the mold, the mixture is made highly plastic. Therefore, the surplus water has to be removed before the concrete is allowed to set.

After the cast has been allowed to harden for twelve hours, it is taken out of the mold and its face brushed with wire brushes to remove the surface cement and expose the aggregates. The surface is then given a bath with weak muriatic acid to reveal the full brilliance of the coloring of the slabs. The casts are then cured for 14 days in a curing chamber which maintains an exact humidity and leaves them with a hard, flint-like surface, and a crushing strength of about 5000 pounds to the square inch—a man-made granite.

The pre-cast panels are then assembled on the concrete foundation of the building and anchored into small structural concrete columns cast in place at each joint. The anchoring is done by an engineering device which keeps the slabs from actual union with the concrete columns, but produces a perfectly water-proof joint and at the same time allows for expansion and contraction.

Colorful Milk Bottles

MILK bottles with the dairy's name or trade mark embossed in bright colors are being adopted rapidly by many of the large dairies. The application of these permanent and attractive colors to glass is a recent development, and represents an interesting application of chemistry.

There are two methods used for colored lettering on glass, called "pyroglazing" and "anigraphing." In the former, the markings are not diminished in brilliance or distinctiveness by washing, exposure to sun, wind, or frost, or rubbing of bottles against each other. They are obtainable in a variety of bright colors such as blue, green, orange, or red. In addition to lending attractiveness to the bottles, especially when filled with milk or cream, they make "pirating" of empty bottles more detectable.

Anigraphing may be likened to lithographing or printing in that any pattern or design that can be transferred to paper can be transferred to glass. The imprint is resistant to ordinary solvents, to washing and cleaning operations, and to ordinary shelf and storage conditions. Anigraphing, like pyroglazing, gives a protective as well as a decorative identity to the container.—*A. E. B.*

Vitaminized Beer

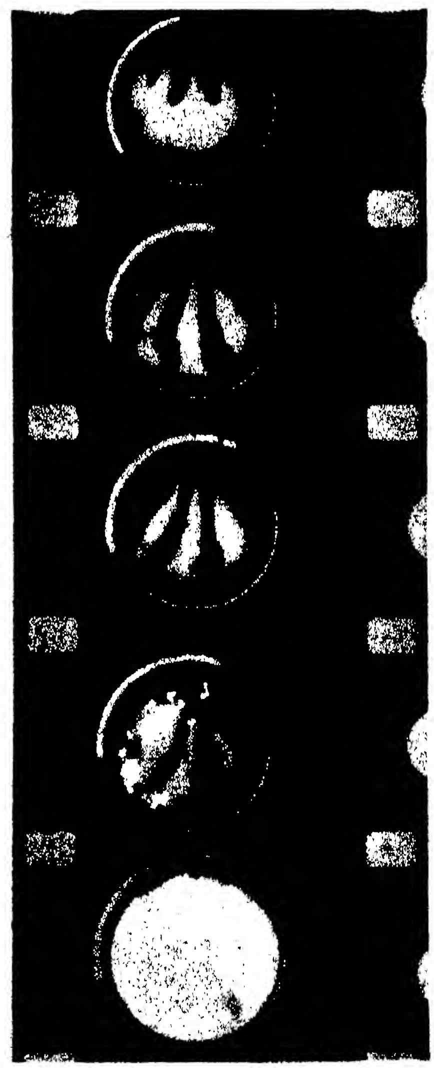
WHEN beer first "came back," a thirsty populace was concerned entirely with its taste and its "kick." But now that the novelty has worn off, enterprising brewers are casting about for new ways of giving their product sales appeal. In view of the current fad for reinforcing various food products with vitamins, it is not surprising to hear of a new process for vitaminizing beer.

Some of the raw materials of brewing contain vitamins, and brewer's yeast is an excellent source of vitamins B and G, but the finished filtered beer contains no significant proportion of any vitamin. Fritz Lux, who describes the process of vitaminizing beer in *Brewers Technical Review*, utilizes the cell sap separated from yeast by supercentrifugalization or by other methods. The inventor of this method says that the cell-free liquid contains 25 to 30 percent of soluble yeast proteins, the vitamins and the enzymes. He proposes the addition of definite proportions of this cell sap to the beer after the main fermentation. The inventor asserts that the vitamins and enzymes mix with the beer and pass through the filter.—*A. E. B.*

Combustion in Diesel Cylinders

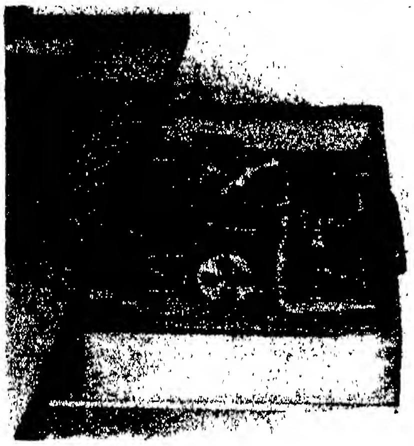
USING special glass windows resisting temperatures up to 3500 degrees, Fahrenheit, aviation research scientists have just discovered how fuel oil burns in a Diesel engine.

New facts which are expected to advance the possibility of using Diesel engines in aircraft have been found by taking high-speed photographs through these windows. These facts were reported by A. M. Roth-



High-speed photographs show flame propagation in a Diesel cylinder

Below: A new type of dictation machine is housed in a desk drawer, and, *right*, is ready for instant use. It leaves both hands free for making notations or holding papers



rock of the National Advisory Committee for Aeronautics Laboratories at Langley Field, Virginia, before the meeting of the Institute of the Aeronautical Sciences.

Mr. Rothrock showed motion picture film before the aviation meeting taken at the rate of 2500 frames a second. The film upset theories about how fuel burns in such engines—opinions which have existed since the Diesel engine was first invented.

The characteristic feature of the Diesel engine is that fuel oil is injected into the air of the cylinders which has previously been compressed by the stroke of the piston. Under compression the air temperature rises until it is high enough to ignite the injected oil. No electric spark is necessary. Previously it had been supposed that the oil began to burn as soon as it came in from the fuel jets. Mr. Rothrock's film proves that combustion occurs only after the fuel fills the cylinder.

G. W. Lewis, director of aeronautical research of the N.A.C.A., said that the new technique should speed research in the Diesel engine field. Heretofore, he said, various types of fuel jets—as only one example—were made and inserted in the cylinders. How well they worked could be determined only roughly as long as it was not possible to see or photograph what was going on inside during combustion. With the new windows and high-speed photography, rapid checks on performance can be obtained.—*Science Service.*

Improved Dictation Machine

EVERY executive using a dictation machine has appreciated the difficulty of placing that useful aid so that it is completely handy to the man at a desk, yet out of the way when not in use. If the machine is mounted on a wheeled iron stand, it interferes with opening drawers when dictating, and may interfere with the side chair when callers come. If located on the desk top, it occupies space needed for papers; and the mouthpiece tube is often in the way.

These inconveniences are avoided by the Howarth Dictation Machine. With this machine the dictator sits facing his desk (or the table used with the desk), just as when dictating to a stenographer, with all his papers in front of him. The machine is fitted into the shallow middle drawer, which is of special design, and the mouthpiece tube rises from the front interior of the drawer. The scale and pointer (which show the position of the stylus on the cylinder) are in plain view at the front edge of the desk. Hence the cylinder number, start and stop positions of the stylus, and errata, can be noted as dictation proceeds, either on letters being answered or on a separate pad.

PLATINUM

WORLD consumption of platinum last year was about 200,000 troy ounces compared with 175,000 in the preceding year. The odd thing is that its price has been approximately the same as that of gold because of the governmental decree raising the price of the latter metal.

New Process for Sulfuric Acid Manufacture

SUCCESSFUL operation of a new plant for making sulfuric acid out of ferrous sulfate has demonstrated the commercial feasibility of reclaiming useful products from a nuisance by-product. The plant in question, built in the middlewest by the Chemical Construction Corporation, is using waste ferrous sulfate in the production of over 100 tons per day of 100 percent equivalent H_2SO_4. A similar plant of equal size is under construction for the same owner in the east. The process appears to be equally applicable for other ferrous sulfate liquors, such as that from steel pickling. It thus opens a field for the possible prevention of stream pollution by pickle liquor from the steel mills.

In operation of the process, says *Chemical and Metallurgical Engineering*, the ferrous sulfate liquor is evaporated to produce a substantially dehydrated material which is then roasted under reducing conditions to yield a strong SO_2 of purity sufficient for use in a vanadium catalyst contact plant. Prior to roasting, as is done in the plant now in operation, green sulfide ores may be mixed with the sulfate to produce additional acid, if this is desired. In addition to SO_2 the roasting yields an iron oxide cinder, part of which is used to neutralize any excess acidity in the feed liquor. Under cer-

tain circumstances the cinder may be used for its iron content in blast furnaces, or it is suitable for the production of pigments.—*A. E. B.*

"TICKET TO MESOPOTAMIA, 3000 B. C."

IF you could travel backward through time to any historic age you liked, would you say to the "time-ticket" agent:

"Mesopotamia, please, 3000 B.C.?"

That is where one archeologist, Dr. E. A. Speiser of the University of Pennsylvania, would like to go for a brief change of historic scenery. If the trip could be managed, he could witness one of the major events in human progress—the beginning of the era of history. Evolution of writing was accomplished about 3000 B.C., and learning to write changed life so radically that Dr. Speiser says: "Nothing like it is seen again until we get down to within earshot, so to speak, of our own times."

Digging at sites such as Ur, Tepe Gawra, and Erech in Mesopotamia reveals the sharpness of changes that took place. Despite the impressive succession of generations of prehistoric folk, who left their pottery, their architecture, and their art to show what they were like, the unlettered ancients remain shadowy and anonymous.

But, says Dr. Speiser: "When we learn that the first independent ruler of Ur was a certain Mesannipadda, that the language he spoke was Sumerian, that he made war on the people of Erech, and that he gave costly presents to his wife whom he mentions by name, we realize at once that quiet and anonymity have departed forever and that history is upon us in full sway. It all began the moment the past had broken its silence."—*Science Service.*

AN ANTI-BEND MOVIE FILM REEL

THE film reel shown in the illustrations is not so much anti-bend as anti-stay-bend. Being of spring band steel, it can be bent freely, but instantly flies back to its

Above: **Close-up of center of new spring steel movie reel.** ***Right:*** **The reel withstands rough treatment**

original alignment. It can even be jumped on without changing the trueness of its lines. While the spokes are riveted to rims, they slide under steel bands on the hub.

Clipping film on this reel is made automatic by wells sunk in the hub. When the film is laid over one of the wells and pressed, film perforations catch in prongs and hold securely until the end of the run.

The new reel does away with the bends and twists in ordinary wire or stamped reels—so fatal to the life of the film and to the smooth, uninterrupted run of the show. This model is for 16 mm. film and holds 1600 feet.

COYOTES MOVE EAST BY MODERN METHODS

THE coyote, "wild dog of the western plains," seems to be moving east. In keeping with its reputation of resourcefulness, this predator is "moving in" by modern means of travel, the automobile and the express train, according to naturalists in the United States Department of Agriculture.

Tourists in the west often purchase coyote puppies and bring them east. They do not find them dependable pets, however, so there is little grief when an occasional coyote escapes. In a few cases eastern sportsmen have brought in young coyotes and freed them, thinking they were fox puppies. From these small beginnings have developed numerous infestations in some of the eastern states.

Coyotes are now present in New York, Pennsylvania, Tennessee, South Carolina, Georgia, Florida, and Alabama, and may be present in other eastern states. In addition to artificial plantings, coyotes are pushing eastward of their own accord, having been recently reported in parts of lower Michigan and Indiana.

The paid-hunter system is advocated by the Biological Survey as the best method of keeping coyotes under control. The payment of bounties often leads to abuses and deception.

Although coyotes are scavengers and, in addition, destroy many rodents, they are all too likely to find it easier to obtain their living by killing poultry and young pigs, lambs, and even calves. For this reason they may become as much a menace to eastern farmers as they have been to the western rancher.

CHEESE WRAPPED IN CHEESE

CHEMISTRY is a versatile science, but it hasn't a cure for everything. Common sense sometimes goes chemistry one better, as illustrated by a new scheme for preventing mold on Swiss cheese. While chemists were studying ways to prevent the deterioration of the cut loaf of Swiss cheese, one of them got the bright idea of wrapping the cheese in cheese.

High-quality Swiss cheese can be made only in "wheels" of 200 pounds or more. Production in smaller sizes causes loss of flavor or suppression of the "eyes" that the

Courtesy The Texaco Star

A fleet of the new streamlined oil trucks described on this page

consumer has learned to demand. However, these large wheels have serious drawbacks. They cannot be cut into sandwich squares without serious loss and one wheel is much too large an order for the usual retail dealer. If he buys a part of a wheel either the cut surface dries out and must be discarded or it develops mold and so causes loss.

Heretofore, the only way to remedy the difficulty has been to process the cheese into bricks by heating and grinding it. Processing works well with some types of cheese but it injures the flavor and removes the eyes of Swiss cheese.

The new method, described by Fred C. Bowman in *Food Industries*, offers a new solution of the difficulty. The standard 200-pound wheel is cut into loaves with the usual wire cutting machine. About 50 pounds of small pieces remain. They are heated and pasteurized, and then molded into blocks of cheese free from holes. They are then cut into sheets 1/8 of an inch thick and are used to veneer the "eyed" bricks. The face of the eyed brick is softened by holding a hot iron near but not against it for a few seconds and then the veneer is pressed upon it and adheres perfectly. All six surfaces of the loaf are covered in this manner, giving a finished loaf that is completely sealed with an impervious layer of pasteurized cheese. It is finally wrapped in tinfoil and parchment paper.—*A. E. B.*

Liquid Copper

LIQUID copper which can be applied to any surface to form a coating of 98.3 percent purity is announced by the Nichols Copper Company. This unique discovery involves pulverizing the metallic copper to such a fine powder that it remains suspended in the liquid vehicle, the composition of the latter being something of a secret. Applied to any surface, "liquid copper" affords complete coverage, the form of the minute particles preventing the appearance of minute gaps in the coating. Two scientists have been at work on this problem for nearly 8 years and after repeated trials, have finally produced the copper in the form required for application and mixing with the vehicle. The maker emphasizes that this new product is not an oxide nor a bronze powder. Tests have shown that it should have a useful life under actual service five to ten years, or longer.—*A. E. B.*

Streamlined Tank Trucks

WE ordinarily think of streamlining as being most effective on vehicles for which extremely high speeds are desirable. Mr. H. W. Kizer, Superintendent of Motor Equipment for The Texas Company, however, believed that streamlining would have many advantages for the company's tank trucks. Six of these have now been built and have proved most satisfactory.

The advantages of the streamline design are economy and ease of operation, greater carrying capacity in relation to size, and increased visibility for the driver—a safety factor well worth considering.

Each truck, although only 26 feet long, has a capacity of 1500 gallons. The engine is mounted in the rear; the clutch, brakes, gear shift, and steering are controlled by air from the driver's compartment.

"Baby Talk" Among Writers

IS it "baby talk" that T. S. Eliot, Gertrude Stein, and other modernists have been giving us in some of their recent writings?

The *Journal of the American Medical Association* interprets the tendency of these writers to link words together by sound rather than by meaning as "essentially infantile."

"One expects the insane to utter every thought that comes into their minds without worrying about continuity or sustained interest," says the medical journal. "Such writing, however, belongs in textbooks of psychiatry rather than in essentially artistic productions of the type intended by James Joyce in 'Ulysses.'"

Man developed reason and intellect in order that he might express himself reasonably and intellectually, the Journal points out in an editorial called "The Psychology of Modernism in Literature."

A poem by T. S. Eliot is offered as an example of the type of writing criticized. It reads:

"If it was to be a surprise
If it was to be a surprise to realize,
If it was to be if it were to be, was it to be.
What was it to be. It was to be, was it to be.
And it was. So it was. As it was. As it is.
As it is as it is. It is and as it is and as it is.
And so on and so on as it was.
Keep it in sight alright."

"Who, one hundred years hence, will quote Eliot or Gertrude Stein as today we quote the writings of Shakespeare, Tennyson, and the Bible?" asks the Journal.—*Science Service.*

Alupak Gaskets

A NEW gasket material of unique properties has been placed on the market under the name of Alupak. The sheets are constructed of alternate layers of thin sheet aluminum and fine wire mesh. An elastic compound binds the sheets together into one flexible piece forming a gasket which,

it is claimed, will hold even on warped and super-heated surfaces, since the gasket actually swells when subjected to heat. This expansion forces a perfect seal on all parts of the flanged surface and fills in all warped or uneven spots.—*A. E. B.*

Tough Glass

DURING the past month or two certain members of a laboratory staff have frequently amused themselves and visitors by tossing glass lenses on a concrete floor. The height of the drop has varied from four to ten feet, and not a single lens has been broken to date. These lenses are not laminated or reinforced by wires or any extraneous mechanical means. They are for optical purposes and, therefore, clear. They can be and have been broken, but it is estimated that the blow required is 13 times as great as that required to break a lens of ordinary optical glass of the same dimensions. Moreover, ordinary glass breaks into relatively large, razor-edged splinters, whereas this glass breaks into less hazardous small pieces with rounded edges.

Peculiarly, this glass is made by violating the traditional "good factory practice" which is considered essential for toughening glass. In ordinary processing, glass is cooled slowly from the molten condition, to minimize the formation of strain. This process is called annealing. But the process used to make these tough lenses reverses the usual procedure. The glass is heated to the softening point, about 1500 degrees, Fahrenheit, and then quickly cooled by means of an air jet, steam jet, or immersion in oil at approximately 400 degrees, Fahrenheit. The result is that the exterior layer of the glass is quickly solidified, while the interior, cooling at a slower rate, contracts and places compressive forces on the exterior. The interior is put under very strong opposite but equal tensions which are revealed by polarized light. Instead of avoiding strains as in the old art, strains are intensified, but their direction controlled to obtain symmetrical stresses. However, this relatively new art is not so novel; those of us who made Prince Rupert drops for amusement employed it.

The utility of toughened glass of this type is apparent for use in industrial goggles, its first commercial application. An ordinary glass lens, though furnishing primary protection to the eye against flying particles of metal, stone, and so on, creates a secondary hazard when it is shattered to form sharp-cutting splinters. Tough glass lenses, on the other hand, resist breakage to a far greater degree, and when broken do no cutting. Glass goggle lenses of this material readily pass twice the shock resistance demanded by United States government specifications GGG-G-501.

These new glasses are not restricted to industrial goggles. They are successfully employed for correcting defective vision, and make the frame, rather than the more expensive lenses, the more delicate portion of eyeglasses. There is but one restriction to the use of such lenses; the minimum dimension must be over three millimeters to retain characteristic features. A thick lens is thus necessary in some extreme cases, but this disadvantage is offset by protection against breakage. Tough glass is also used in various types of bifocal and curved lenses.

The superior physical properties of tough glass deserve further study. Because of this superiority, its use for non-optical industrial purposes is suggested. Its thermal properties in larger sizes should be closely observed, particularly with reference to large and bulky pieces. Naturally, in many of these extended applications, the tough glass will not require the grinding and polishing essential for optical requirements.—Arthur D. Little's *Industrial Bulletin.*

ALLOY WIRE

NEARLY a mile of three quarter inch nichrome ribbon is used in the electrical heating elements of the special annealing kiln of Corning Glass Works in which the disk for the 200-inch telescope is being gradually cooled.

Rubber Lining for Chemical Tanks

GREATER resistance to both acids and alkalis is claimed for a new hard-rubber lining for tanks that has been announced under the designation of MR-10 by the American Hard Rubber Company. The lining possesses a highly glazed surface and is bonded securely to a relatively thin layer of soft rubber which is vulcanized to the steel tank, providing an elastic connection to compensate for thermal changes and protect against shocks. In the installation of this lining, soft rubber fillets are used at all corners.

The compound used for the lining has been improved in pliability and, on account of the high gloss surface, is easier to clean. Acid resistance is said to be better, permeability less, and the cost no higher.—*A. E. B.*

Why We Can't Drink Sea Water

THE inorganic salt content of sea water is very much higher than that of the blood of man and other terrestrial animals. The salt content of the water of the Atlantic and Pacific oceans is over 3 percent, while that of the blood plasma of man is about 1 percent. Most of the salt in sea water is the ordinary sodium chloride as is the case with the human blood plasma, but in the salt water is proportionately more magnesium sulphate than in the human blood plasma. It is also known that excess salts in the blood are eliminated by the kidneys. This elimination requires the elimination of an increased amount of water, which, in the first instance, is taken from the blood plasma. In the case of a person, therefore, who tries to ease his thirst by drinking sea water, the following things happen:

Because of the higher salt content of the sea water there is an increase of concentration of inorganic salts of the blood. This tends to draw water from the tissues and increase the thirst sensation. At the same time the kidneys are eliminating these excess salts together with a great deal of water from the blood plasma. This further increases thirst. Lastly, the magnesium sulphate in the sea water is not readily absorbed from the intestine, and the presence

of this salt in the intestine holds back a certain amount of the water from absorption. It is therefore clear that endeavoring to stop thirst by taking sea water aggravates the thirst and hastens death. People will therefore live longer and with less discomfort by taking no water at all than by drinking sea water. People can survive longer without water if they abstain from taking food.—*Journal of the American Medical Association.*

An Experiment in Artificial Daylight

ALL-DAY daylight for dark court apartments is an experiment now being tried by the Bowery Savings Bank of New York at a 14-story apartment house.

Regardless of weather conditions, light now streams through the windows of all court apartments, from the tenth floor down, in that building. Formerly some of these apartments were so dark that they required inside artificial illumination even on bright days. Now, according to a statement issued by the real estate department of the bank, tenants can easily read newspapers in corners of the rooms farthest from the windows.

The workings of the plan are simple. Courts have been painted white and in them have been placed batteries of 1000-watt Nova-lux lamps. Light from these lamps strikes the white walls of the court and the rays are deflected through the windows.

"The rays are so diffused," says the bank's statement, "that light coming through the windows has no glare and no resemblance to artificial light. As light pours in, it resembles mild sunshine more than anything else."

The lamps are controlled from a central switch in the basement which, in turn, is controlled by a time clock. When lamps are turned on in the morning, it requires 15 minutes for them to give out maximum illumination and when they go off at night another 15 minutes is required for the gradual step-down.

"We don't wish to awaken tenants in the morning with a sudden flood of light," says the bank's statement. "The step-up and step-down system approximates as closely as possible conditions of daybreak and twilight."

The new system is an experiment. If it works out, the bank believes it may be a first step toward materially improving living conditions in urban communities and may pave the way toward the easier renting of thousands of apartments now facing on courts.

Capturing the Songs of Birds

A REPORT just received by Dr. Roy Chapman Andrews, Director of the American Museum of Natural History, from Albert R. Brand, member of the American Museum-Cornell Ornithological Expedition which started out in mid-February for an extensive tour of the United States to photograph birds and record their songs, reveals that the expedition, now in Louisiana, has covered 15 states, traveled about 3000 miles in the past two months, and recorded some 30 species of birds in Georgia, Florida, and Louisiana. The expedition's next objectives are Texas, Oklahoma, and the Rocky Mountain States. It will probably be on active service in the field all summer.

Leading the expedition is Dr. Arthur A. Allen, Professor of Ornithology at Cornell, whose unusual and beautiful movies of nesting birds are well known to all bird lovers. Paul Kellogg, Instructor of Ornithology at Cornell is in charge of the sound truck, microphones, and recording apparatus; while Dr. George M. Sutton, Curator of the Cornell Museum, and a bird artist of distinction, is making color reproductions of the birds.

Albert R. Brand, Associate in Ornithology at the American Museum, is sponsoring the expedition. Since 1930 Mr. Brand has been collecting the sounds of native birds, and has had a number transferred to phonograph records. These are available to schools, nature study groups, scout troups, and bird students generally, and are great aids in learning the bird songs. Up to 1935 about 115 bird sounds had been recorded on movie film and are in the collection. By the time the expedition returns from the field it is expected that almost 200 species will have been recorded.

"The expedition," says Mr. Brand in his report, "is getting material valuable to science and of popular interest, without in any way disturbing or molesting the subjects. Not a single bird is being collected. More than a mile of sound film has been taken thus far. These are the first sound records that have ever been obtained of many of the species. A primary objective of the expedition is to secure the sound and to take motion pictures of those species of birds that are becoming scarce."

Cadmium Battles Corrosion

TO combat the extraordinarily severe conditions encountered in the Antarctic, Admiral Richard E. Byrd had a great deal of his steel equipment cadmium plated. This metal is said to provide the greatest protection against rust, corrosion, and fatigue with a minimum thickness. Although not so attractive in appearance as chromium plating, it is finding a rapidly growing field in utilitarian applications where beauty of the finished plated surface is a secondary consideration.

The combination of iron with other metals to produce the high-strength alloy steels required for airplane construction and for quality tools and parts renders the resulting product far more subject to corrosion in most cases than the iron itself. For this reason protection from corrosion becomes extremely important. Cadmium has been found to be the most effective and economical metal to afford this necessary protection.

The aforementioned examples constitute but a few of the many applications of cadmium on similar products. Most new automobiles are furnished with cadmium-plated tools as part of their standard equipment and numerous vital parts of every car are so protected. A glance around a well-equipped service station will disclose entire kits of tools free from rust, protected by cadmium. A visit to a hardware store will reveal quantities of cadmium-plated pliers, wrenches, screw-drivers, screws, bolts, nuts, hinges, locks, and other hardware of many kinds.—*A. E. B.*

CURRENT BULLETIN BRIEFS

BETTER HOMES IN AMERICA GUIDEBOOK. The current drive on housing in the United States makes this 1932 publication especially valuable. It outlines clearly and succinctly the purpose of the Better Homes Movement and how it may be successfully promoted. *Better Homes in America, 101 Park Avenue, New York City.—5 cents.*

PRESERVATION WITH NO-D.K. An excellent treatise on the various methods of preserving wood from decay and termites, by means of a natural wood creosote oil. *Write for Bulletin 635-A, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

PRINTING SHOULD BE INVISIBLE,' by Mrs. Beatrice Warde, is an excellent exposition of the fact that the actual typography used in advertising should carry the story but must not of itself detract from the message. *The Marchbanks Press, 114 East 13th Street, New York City.—Gratis.*

HYDRAULIC POWER TRANSMISSION. A résumé of the adaptability of petroleum oils to hydraulic power transmission of various types. Thoroughly illustrated with line drawings and photographs. *Write for Bulletin 635-B, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

PUBLIC EDUCATION IN THE VIRGIN ISLANDS, by Katherine M. Cook, tells how education has been made an integral part of social and economic rehabilitation of the Islands. *Superintendent of Documents, Washington, D. C.—10 cents.*

CHEMISTRY IN THE SERVICE OF SCIENCE, by Dr. A. T. Lincoln. A pithy little report which surveys briefly the whole field of science and what chemistry has contributed to each branch. *Write for Bulletin 635-C, Scientific American, 24 West 40th Street, New York City.— 3 cent stamp.*

AMERICAN TYPE LOCOMOTIVES. A large sheet is available showing the development of the Eight Wheel or American type locomotive from 1867 to 1900. An interesting portrayal of locomotive development. *Railway and Locomotive Historical Society, Inc., Baker Library, Harvard Business School, Boston, Mass.—Gratis.*

PRINCIPLES OF PUBLIC ADDRESS SYSTEMS. A mimeographed booklet containing numerous diagrams and tables which serves to give a background of knowledge regarding public address systems and the equipment used therein. *Write for Bulletin 635-D, Scientific American, 24 West 40th Street, New York City.—50 cents.*

THE INTERNATIONAL LABOUR ORGANISATION MEMBERSHIP OF THE UNITED STATES AND ITS POSSIBILITIES. April 1935 issue of *International Conciliation.* A discussion of the place of the United States in the International Labour Organisation, telling of the benefits which may be brought about to laborers of all countries if harmonious international action can be achieved. *Carnegie Endowment for International Peace, 405 West 117th Street, New York City.—5 cents.*

LITTELFUSE PRODUCTS. An unusual little pamphlet giving general hints and helps in regard to electrical fuses. Covers fuses for aircraft, radio, laboratory purposes, automobiles, and marine use. Also describes novel gaseous discharge fuses. *Write for Bulletin 635-E, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

THE PORT OF NEW YORK AUTHORITY FOURTEENTH ANNUAL REPORT. An illustrated booklet of 66 pages, including a folded map of the Port District, telling of the work accomplished during 1934 as a result of coördination between the states of New York and New Jersey. *Port of New York Authority, 111 Eighth Avenue, New York City.—Gratis.*

THE NEW SCIENCE OF LIGHTING, by Matthew Luckiesh and Frank K. Moss. The rapid strides which have been made in illumination engineering within the past few years are here brought forcefully to the attention of the reader. Minimum lighting for particular purposes is outlined in text and drawings. *Write for Bulletin 635-F, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

DON'T BE TWISTED. When a life insurance agent tries to persuade you to drop your policy with one company and take out a new one with another, you are being "twisted." This little folder tells about the illegal practice of twisting and how you can protect yourself from it. *National Better Business Bureau, Inc., Chrysler Building, New York City.—Gratis.*

THE STORY OF KNEE ACTION. A beautifully illustrated little booklet written in simple language to put over to the reader the essentials of knee action as applied to motor cars. How present types of front-end suspension have evolved and what has made them possible are clearly depicted. *Write for Bulletin 635-G, Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

INDUSTRIAL DIXIE

(Continued from page 289)

This brief survey indicates the significant strides made by the South in its industrial progress. In two generations, this great section of the United States has adjusted itself to the exigencies of changing eras. The deep rural plantation culture and agrarian society have faced the necessity of a fundamental shift in emphasis and economic philosophy. Yet we must not forget the splendid record that has been established in retaining those vital social values inherent in the characteristics of southern culture and tradition. Thus does the history of southern adaptation and development offer an example and a challenge to the entire nation in meeting the complex problems of the present recovery period.

Books SELECTED BY THE EDITORS

(*Continued from page* 284)
press and from speeches of noted men relating to all phases of warfare. In many cases opposing arguments are placed in parallel columns.—$2.15 postpaid.—*F. D. M.*

GUIDING YOUR CHILD THROUGH THE FORMATIVE YEARS

By Winifred De Kok, M.C.R.S., L.R.C.P.

A SHORT treatise on child management from the age of one to five, written from the psycho-analytic point of view. We supposed we were not old-fashioned, but if this book is not a bit "strained" in certain directions, then we are fogiefied, after all. It dwells quite largely in the general realm of excreta and other aberrant tendencies claimed to be typical of the child mind. Still, if you like that sort of thing, and think it is typical of children's thought-interests, this is your book. It certainly isn't a wanton piece of skatology, anyway—just psycho-analysis in one of its more frenzied forms.—$2.15 postpaid.—*A. G. I.*

A GUIDE TO BIRD SONGS

By Aretas A. Saunders

SINCE we, in common with a lot of other people, are entranced with the music of birds, we found ourselves endeavoring to learn the system explained in this book of recording bird songs. This system, while resembling in a broad way musical notation, is in reality so graphic and simple that it may be readily understood by all. It provides an easily workable key by which to record and recognize the peculiar characteristics of any bird song heard and to identify the song even if the bird is unseen. Study of this book should add a new and fascinating element to the bird lovers' field excursions.—$2.65 postpaid.—*F. D. M.*

PAN-AMERICAN ENGLISH AND SPANISH DICTIONARY AND TRAVEL GUIDE

By Lewis L. Sell, Ph.D.

IN our experience no published book has ever approached this one in completeness. That ever-increasing army of commercial travelers sailing or flying to Latin America, tourists, motorists, and others will find in this handy pocket book of over 600 pages an amazing and valuable accumulation of information on all the Latin-American countries. There are given: official representatives in the U. S., passport and documents necessary, routes and transportation facilities to and within all these countries, principal facts regarding each, principal cities and all one need know about them (hotels, customs, clubs, trade, amusements, monetary units, and so on—including warnings on what not to do and what not to say!), peculiarities as compared with their neighbors, climate, technical language, and a host of other things. Much information for the dyed-in-the-wool sightseer is also given.

This veritable mine of information is an education in itself in smoothing the way of the traveler and should be the prerequisite of the traveler to the countries south of us.—$2.65 postpaid.—*F. D. M.*

SEX PRACTICE IN MARRIAGE

By C. B. S. Evans, M.D.

THIS little book—which can be read in half an hour contains concentrated practical advice which would have saved many a marriage from going on the rocks, had husbands known its contents earlier. Its author is a member of the Faculty of Obstetrics and Gynecology at the Northwestern University Medical School, was a member of the White House Conference Committee on Maternal Care, and is in actual practice of medicine. Plenty of men think they "know it all," and blunder into the divorce court because they blundered clumsily in marriage and then accused someone else of frigidity. To use knowledge, you must first possess it. If something is wrong, maybe it is yourself, after all. If not, probably this isn't your book.—$2.10 postpaid.—*A. G. I.*

AMERICAN SCIENTISTS

By C. J. Hylander

AMERICA has reason to be proud of her scientists, both living and dead. Any listing of them would be sure to include several whose work has had far-reaching significance—social and economic. This book, by a man who has taught science to boys and knows how to present facts that will interest them, will make exciting reading for young people. The stories in these pages of 27 famous American men of science carry the reader through thrilling explorations in desert and jungle and far into the depths of the ocean, through all the intricate details of chemical experiments, and through laboratories whence have come such important discoveries as that of heavy water. This is a worth-while addition not only to youthful libraries, but to the youngster's individual library. —$2.15 postpaid.—*F. D. M.*

THE MODEL RAILROAD RIGHT OF WAY

By Oliver Whitwell Wilson

WITHIN the 92 pages of this book the model builder will find designs for many accessories to be added to his model railway.—$2.65 postpaid. —*A. P. P.*

HOME CRAFTSMANSHIP

By Emanuele Stieri

BETWEEN the covers of this 346-page book will be found instructions for handling all kinds of tools that are ordinarily used in the home workshop. Hand tools and motor-driven tools alike are given careful consideration and the reader is told exactly how to obtain the best results with them. The first chapter, concerned solely with wood, will be of inestimable value to the man who likes to build his own furniture or to make repairs around the house. Included in the book are various projects to be undertaken. Thoroughly illustrated with clear line drawings and furnished with a complete index. The bibliography refers the reader to other books on the same subject.—$2.70 postpaid.—*A. P. P.*

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—O. D. MUNN, Publisher.

SCIENTIFIC AMERICAN

Copper in the Brewery (See page 1)

VOLUME 153 • NUMBER 1

TELEPATHY IN A PSYCHIC MEDIUM

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

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COVER

28/9/'36

ONE of the many uses to which copper is put, because of its corrosion resistance and other desirable qualities, is in modern breweries. Our cover photograph shows a group of copper brew kettles at Rupperts Brewery. The story of copper and the tremendous strides which have been made in the development of copper and copper alloys is told in the article on page 20 of this issue.

The SCIENTIFIC AMERICAN DIGEST

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ACROSS THE EDITOR'S DESK

WITH the summer months calling one and all to the outdoors in pursuit of recreation, the subject of snakes and snake bites becomes of paramount interest. Whether you are a confirmed hiker who searches out the most remote wilderness in which to commune with Nature, or whether you just load the family into the car for a day's picnic, there are certain facts in connection with snakes which, for your own sake and that of others, you should know. Probably no other subject has been treated with more stretches of the imagination and with less regard for actual facts than has that of snake bite and what to do about it. Accordingly, an article covering the latest aspects of this situation has been prepared, and is scheduled for publication next month. Having been checked carefully by acknowledged experts, the article may safely act as a guide for those whose work or pleasure takes them to regions where venomous snakes are likely to be encountered. The article tells not only of the *correct* method of treating snake bite, but also how to avoid being-bitten.

●

WHEN you turn an astronomer-artist-mechanic loose on a problem such as designing a sun-dial which really tells time, you would naturally expect a workable result. And such a result has been reached by Russell W. Porter, who tells next month of the design of sun clocks, which at first glance appear to be combinations of microscopes, ordinary clocks, and a few other little gadgets. But Mr. Porter, whose writing and drawing ability is well known to our readers, can tell his own story much better than we can, so our best bet is just to say: Don't miss this *practical* article, free from flowery allusions, that will increase your respect for the time-keeping qualities of sun clocks.

●

A FAVORITE source of material for the writers of so-called scientific fiction is the planet Mars, undoubtedly because of the undisputed fact that the planet is more or less similar to our own world. Discriminating readers can wade through such stories, if they do not take them too seriously, and be amused by them, but there is little to be gained by so doing, other than whiling away time. On the other hand, professional astronomers are constantly adding to our store of knowledge regarding Mars, and when Prof. Henry Norris Russell writes of the most recent telescopic work with the red planet, the reader may be sure that he will not only be interested by the story, but will also take away from it many facts that will add to and possibly amend some of his preconceived notions about the subject. Such will be the case next month, when Professor Russell's regular feature will deal with some of the latest facts about Mars.

COMING

- **Snake Bites; How to Treat and Avoid Them, by W. A. Bevan**
- **Mars, by Prof. Henry Norris Russell**
- **"The Seven League Boots of Photography," by Jacob Deschin**
- **Flood Control of the Lower Mississippi River, by R. G. Skerrett**
- **"Sun Clocks," by Russell W. Porter**
- **"What are Positrons?" by Prof. E. U. Condon**

●

ADVANCED amateur photographers: The interest which you have manifested in the series of articles on photography which have appeared in these pages during the past year and a half (over a thousand of you have written to us on one phase of photography alone) has led us to an important decision. The feature article on telephotography, by Jacob Deschin, to be published next month, will be the last of the series. But . . . hold on a minute! We have planned to give you a corner of the magazine all to yourselves. Each month, from now on, a department all your own will be published, where specific problems will be discussed for the benefit of all. This arrangement will make it possible to concentrate photographic material for ready reference, and to give you the latest and best information in compact form. You asked for this: Go to it! The first appearance of the department will be in our September number.

●

WHEN man harnesses Nature, for whatever purpose, he often finds that he has a real battle on his hands. Of such magnitude is the work which modern civilization has demanded must be done on the Mississippi River. Part of the story was told in our February number—"Canalization of the Upper Mississippi River." Next month the other half will be presented: Flood control of the lower Mississippi River. Some facts and figures will give an idea of the scope of the problem: 650,000,000 cubic yards of earth will be placed in levees; the levees range in height from 20 to 30 feet; there will be 1900 miles of them and they will protect 12,000,000 acres from floods when the work is completed. But you will have to read R. G. Skerrett's article next month to get the whole picture.

●

"WHAT are Positrons?," is the title of our pure science article for next month, in which Prof. E. U. Condon, of Princeton University, gives a clear insight to one of the more recent advances in atomic physics. So rapidly does science progress that it frequently seems that the average intelligent person must be left far in the rear. Knowing full well that our readers want to keep up with this progress, we present, from time to time, articles such as Prof. Condon's, which serve to tell, in understandable language, the present status of certain important phases of research in pure science.

Orson D. Munn

Editor and Publisher

Personalities in Science

Photo by Oscar S. Marshall

DR. JOHN D. STRONG

FOR almost a century astronomers have coated the glass disks of their reflecting telescopes with a layer of silver about one 250,000th of an inch in thickness, to form the mirror which reflects the star light to a focus, and this coating has always been made from a chemical solution in which the glass was immersed. About 1928, several men of science, mostly physicists, began developing a wholly different process called the metallic evaporation process, and that method has already proved so satisfactory that a number of laboratories are now busy coating telescope mirror disks with metal evaporated by intense heat, while others are hurriedly preparing equipment to make mirrors in the same manner.

Three or four years ago only small mirrors could be coated. Later, mirrors as large as 30 inches in diameter were successfully made. Recently the mirror of the 60-inch telescope at the Mount Wilson Observatory was coated with aluminum by the new process, and still more recently the world's largest mirror disk, 100 inches in diameter, was successfully coated with the same metal. This exacting work was done by Dr. John D. Strong of the California Institute of Technology, at Pasadena. Dr. Strong, whose photograph, caught while he was at work in his laboratory, is shown on this page, was one of the pioneers in the development of the metallic evaporation process, and was the first discoverer of a *practical* technique for the use of aluminum, a metal which is superior to others, mainly because it reflects the various parts of the spectrum of light more uniformly.

If a metal is heated to a high enough temperature it will be evaporated like water, and the vapor will recondense on cool neighboring surfaces. This is the essence of the new method. Little pieces of the chosen metal are hung on small helical coils of tungsten wire, which are then flashed white hot by passing an electric current through them. The metal on the coils is not merely melted; it is vaporized. The glass disk is placed a few inches distant, but unless the intervening air were removed, the atoms of the metal could not fly straight across to the glass, because they would collide with the obstructing air molecules, and the result would not be a mirror. Hence a bell jar is placed over the whole set-up, and a very fine seal is made at the bed-plate on which it rests. The air is then pumped down to almost one 10,000,000th of normal atmospheric pressure. For the 100-inch mirror this pumping preparation required eight hours. A current of low voltage next heats, in turn, each of the several tungsten coils arranged around the mirror, and evaporates the metal in a few seconds. A coat one 250,000th inch thick is applied — just as with the former silver.

How simple it all sounds! In practice, however, there are many technical details which can be learned only by an extended apprenticeship, especially if the worker is not accustomed to high vacuum technique. Keeping small-eared mosquitoes out of a screened house in some parts of New Jersey is easy, compared with keeping air molecules from crawling in through the joints that surround a high vacuum.

An aluminum mirror, deposited in this manner, looks so wholly different from the familiar aluminum of pots and pans, that nearly everyone mistakes one for a brilliant silver mirror. Aluminum reflects 89 percent of the visible light and, unlike silver, 80 percent of the ultra-violet (of immense value to astronomy). The metal is automatically protected, as soon as the air strikes it, by a thin, transparent coating of very hard oxide (corundum, sapphire), hence the coat is far tougher than silver coats.

Photograph by Richard T. Dooner

FROM THE FAR REACHES OF WESTERN CHINA

THE first and only habitat group in the world of the takin, a curious form of mountain antelope, has just been placed in the Free Natural History Museum in Philadelphia. The takin (*Budorcas taxicolor*) is a species of ruminant that is found in the almost inaccessible mountains of Western China where it lives in thick rhododendron forests at altitudes of from 7000 to 16,000 feet. It is covered with yellowish-brown hair and has curved horns similar to those of the gnu. The specimens for the museum group were collected by Brooke Dolan, II, and were mounted by Louis Jonas. The erection of the group was directed by Harold T. Green.

Photo by George Masa

Sunset at Indian Gap in the Great Smokies, on the Appalachian Trail

THE APPALACHIAN TRAIL*

A Key to Nature Study . . . For Pedestrians Only . . . A Project of Real Magnitude . . . From the Wilderness of Maine to Northern Georgia

By MYRON H. AVERY

THE Appalachian Trail is a continuous marked foot-path extending through the mountain wilderness of the Eastern Atlantic States. It is a skyland route along the crest of the ranges generally referred to as Appalachian—hence the name of the Trail. It extends from Katahdin, a massive granite monolith in the central Maine wilderness, 2050 miles south to Mt. Oglethorpe in northern Georgia. At the present time this master Trail has been completed, marked and measured except for 75 miles in Maine, extending from Grafton Notch to Mt. Bigelow, and 40 miles in the eastern Great Smokies where the National Park Service is now building a new trail. The Trail traverses 14 states. Its greatest elevation is 6641 feet at Clingman's Dome in the Great Smokies. It is slightly above sea level where it crosses the Hudson River.

A project of real magnitude, the Appalachian Trail might seem to have been the result of many suggestions. It can, however, be traced directly to one man—Benton MacKaye, of Shirley Center, Massachusetts. Forester, philosopher, and dreamer, Mr. MacKaye conceived the plan of a trail which, for all practical purposes, should be endless. He regarded it as the backbone of a primeval environment, a sort of retreat or refuge from a civilization which was becoming too mechanized. He first presented his dream in an article, "The Appalachian Trail—an Experiment in Regional Planning," in the October, 1921, issue of the *Journal of American Institute of Architects.* Others had advanced suggestions of extensive trails in the New England States but the conception of this super-trail was solely MacKaye's. His proposal aroused interest among leaders of the outdoor clubs. The clubs in New York City were the first to undertake actual work on the Trail. Under the leadership of Raymond H. Torrey, the first section of the Trail was opened and marked during 1923 in the Palisades Interstate Park. For it, Major William A. Welch, General Manager of the Park, designed the distinctive Appalachian Trail marker and monogram. The New York-New Jersey Trail Conference was organized and the Trail was carried west toward the Delaware River. Pennsylvania was a seat of early activity.

To better gage the extent of this undertaking it is necessary to turn back 12 years and survey the existing trail systems which could be incorporated into the Appalachian Trail, and the organized groups which could then be

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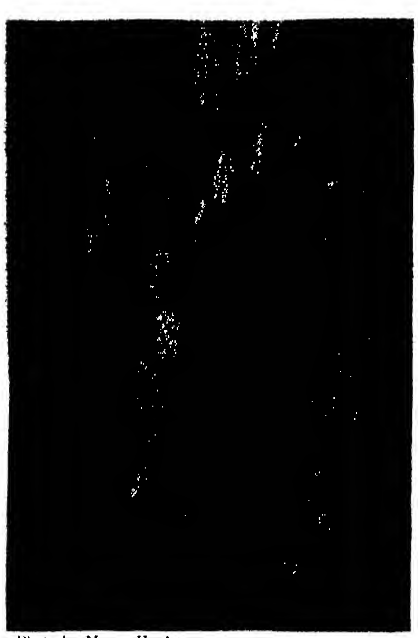


Photo by Myron H. Avery
The Trail leads travelers through regions where natural caves abound

enlisted to further the project. First and most striking is the fact that all outdoor organizations in the East were confined to New England and New York. The Hudson River was the frontier to the south or west.

The existing trail systems which could be incorporated into this super-trail numbered four. First, there were the splendidly maintained Appalachian Mountain Club trails in New England. However, until the completion of the Appalachian Mountain Club chain of huts, the east and west axis of this system did not develop; previously it had been a series of north and south trails. In Vermont the lower 100 miles of the rapidly developing "Long Trail" could be utilized. Between the White and Green Mountains was the Dartmouth College Outing Club trail system. In New York there were the comparatively narrow Bear Mountain and Harriman sections of the Palisades Interstate Park. This was all—perhaps 350 miles out of the necessary 2050. Originally, however, the Trail was thought to be only 1200 miles; its actual development has shown the distance to be almost twice that. In addition to these four sections—in the South—were the National Forests, where connected skyline trails have been subsequently developed to a degree unanticipated by those who early formulated the Appalachian Trail route.

Courtesy Potomac Appalachian Trail Club

The Appalachian Trail

The first enthusiasm aroused by Mr. MacKaye's proposal flared, waned, and, by 1926, had practically died out. The project was moribund; it had degenerated into a fireside philosophy. It was then that Arthur Perkins, a retired lawyer of Hartford, Connecticut, resurrected the project and made it once again a vital, living thing. The enthusiasm and the momentum which he aroused have survived and to these factors is due the practical completion of the present Trail project.

It is interesting to note that the Trail has been the pioneer. Interested individuals have carried the route forward, then after them have come the clubs to utilize and maintain the Trail. One might have expected the reverse; that is, that the clubs would precede the Trail. By 1927 the frontier had receded to central Pennsylvania. With the exception of the three-year-old isolated Smoky Mountains Hiking Club at Knoxville, there were no organizations below Harrisburg. The penetration of the Southern Appalachians began with the formation at Washington, D. C., in late 1927, of the Potomac Appalachian Trail Club. Numerous other Appalachian Trail Clubs followed, so that, with insignificant exceptions, the entire trail route is now apportioned among these energetic organizations. These clubs, aiding in the Trail project, comprise the Appalachian Trail Conference. The Conference functions through a Board of eighteen managers, three being elected from each of the six Districts into which the Trail region is divided. The Chairman of the Board presides as the Appalachian Trail Conference's executive officer.

There have been many experiments in the development of a standard marker for the Trail. The museum collection is extensive. The earliest marker was an embossed, copper square with the trail insignia. Its softness rendered it an easy prey to souvenir hunters, so Mr. Perkins designed a diamond-shaped, galvanized iron marker with the Trail monogram printed on it by a rubber stamp. The marker is then varnished. However, the main reliance in marking the Trail is a rectangular paint blaze, six by two inches. These are placed fore and aft—like highway markers—in the direction of travel. White is the prevailing color, with blue for side trails. Because of local conditions, however, the main Trail blaze in New York and New Jersey is painted yellow; while in Connecticut and a small section of Vermont it is blue. The Trail Conference has issued a printed *Manual on Trail Construction*. There is only one approved blaze symbol. This is the double blaze—two super-imposed blazes or markers which constitute a warning of an obscure turn or change of direction, which might otherwise be overlooked.

Of primary importance is the issuing of guidebooks to the Trail. The measuring of the Trail and obtaining of the data has kept progress with the actual construction. A great number of local guides have crystallized into a series of five guidebooks to the entire Trail. Four have been issued. The fifth, from the Virginia-Tennessee line to the southern

Photo by Myron H. Avery
Many of the wonders of nature are revealed to followers of the Trail

end of the Trail, awaits the completion of the new trail in the Great Smokies. The Conference has also issued a comprehensive pamphlet, detailing the history, route, guidebook data, and literature of the Trail project.

Shelters, closed and open, are absolutely essential to the Trail. The ideal is a continuous chain of such structures at intervals of a moderate day's journey, say ten miles. In many sections, such as the White and Green Mountains and parts of Pennsylvania and Virginia, this goal has been accomplished. Available public accommodations have been carefully sought out and indicated in the Trail data. This meets the needs of the non-camping hiker. Even in the Maine wilderness one may tramp 173 miles for seventeen days and find, each night, satisfactory public accommodations in the form of a sporting camp, an institution peculiar to Maine. In the territory of the Potomac Appalachian Trail Club a similar eleven day trip of 170 miles is possible.

AND now a brief word as to the route or geography of the Trail. From Katahdin in Maine, the Trail leads for 250 miles through an utter wilderness, past lake and stream over a disconnected series of peaks. It meets the first pronounced mountain group in the White Mountains of central New Hampshire, which it crosses from east to west. Near Rutland, Vermont, the Trail turns south for 100 miles along the Green Mountains. In western Massachusetts and northwestern Connecticut the route leads along the Berkshire and Taconic groups, the worn-down remnant of a much loftier range.

The Hudson River is crossed at Bear Mountain Bridge. Then the Trail leads, close to the New York-New Jersey line, over a seemingly endless series of ridges to the Kittatinny Mountains at High Point Park. Here, for the first time, a narrow ridge crest indicates the route.

Photo by Samuel Merrill

The northern-most extremity of the Appalachian Trail is at Mt. Katahdin in Maine (see the map on opposite page), viewed here from across Katahdin Lake

Photo by H. C. Anderson

One of the official signs designed to guide pedestrians along the Trail

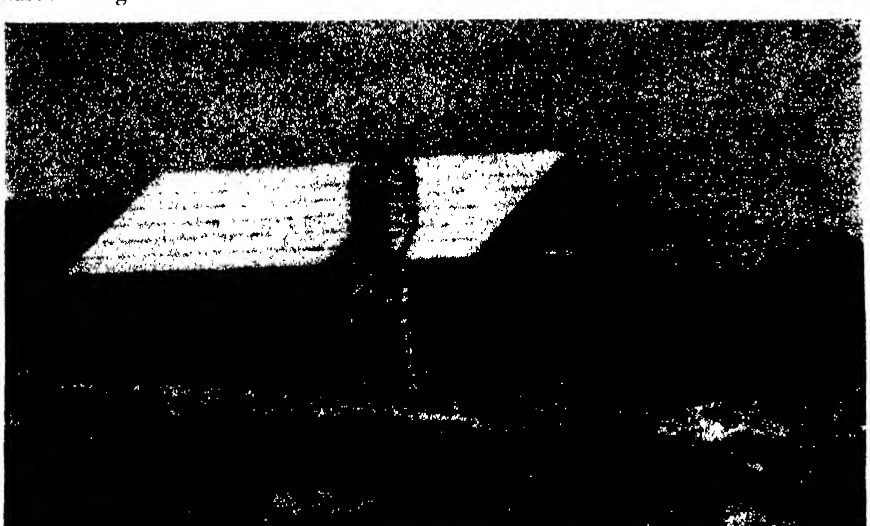


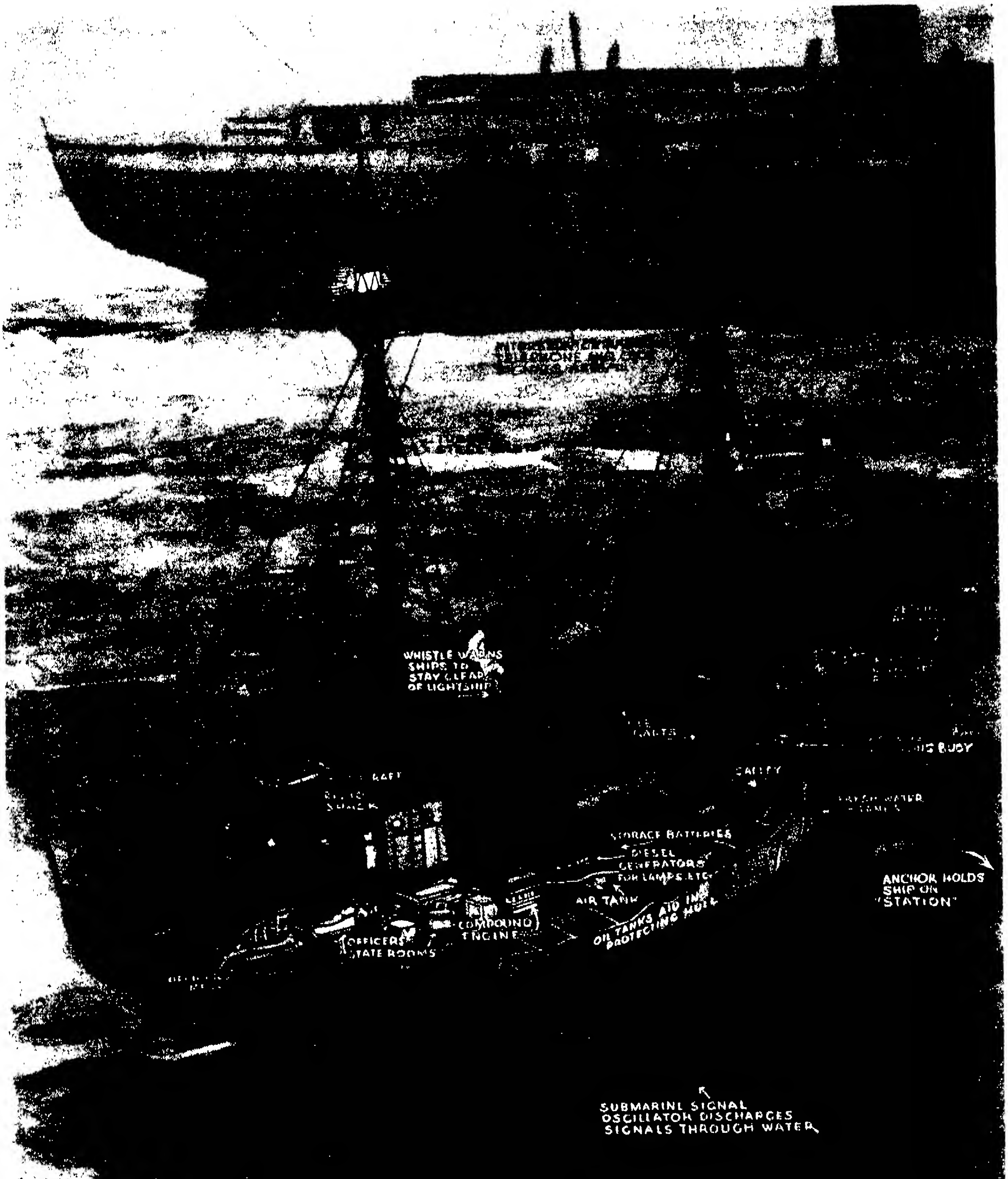
Photo by Vivian Robb

A stone shelter house on the Appalachian Trail

Beyond the Delaware River, this front range of the Alleghenies becomes the Blue Mountain; when the Susquehanna River is crossed the same range has assumed the name of North Mountain. After seven miles along North Mountain occurs the first major change of route; the Alleghenies are left and the Trail crosses the Cumberland Valley by secondary roads to the northern base of the Blue Ridge. Here commences the range which is followed to the southern terminus of the Trail.

THROUGH southern Pennsylvania and Maryland, where it bears the name of South Mountain, the Blue Ridge continues as a narrow crest line where Trail location offers a few problems. Three hundred miles south in Virginia, where the Roanoke River breaks through the range, the Blue Ridge forks. These forks, sometimes 100 miles apart, form an immense oval, coming together again at Springer Mountain in Georgia, 20 miles from the southern terminus of the Trail. The ultimate route utilizes the eastern rim of the fork as far as New River, then crosses the plateau between the rims to the western fork at the Iron Mountain and continues south. At the southern end of the Great Smokies a cross-range, the Nantahala Mountains, leads back to the eastern rim or Blue Ridge, which is followed uninterruptedly to Mt. Oglethorpe, the southern terminus of the Trail, where the Appalachian Mountains end abruptly.

This brief résumé merely serves to indicate the character of the Appalachian Trail. Its successive changing zones of bird, animal and plant life fascinate the traveler. It is indeed a guide to the study of nature. Remote for detachment, narrow for chosen company, winding for leisure, lonely for contemplation, the Trail leads not merely north and south but upward to the body, mind, and soul.



Drawn especially for Scientific American

FOR GREATER SAFETY AT SEA

SINCE the ramming and sinking of the lightship *Nantucket* by the S.S. *Olympic* on May 15, 1934, considerable study has been expended on the design of a strictly modern lightship which will give the greatest possible safety to shipping and also to the lightship and her crew. As shown in the above drawing, Lightship *No. 112* will be provided with sturdy steel masts carrying powerful flashing lights. Amidships will be a four-way compressed air horn and warning whistle. Numerous life-boats and rafts will be placed for ready access by the members of the crew in case of accident.

The new vessel will be 149 feet long, of 31 feet beam, and will have a mean draft of 13 feet. She will have a displacement of 915 tons and will be powered with a 600-horsepower engine. Boiler pressure will be 165 pounds.

OUR POINT OF VIEW

85 Billions!

THE splendid results that are possible from the present housing program, as discussed in these pages last month by James A. Moffett, sound very encouraging. We agree with him that it can start factories humming and put millions of men to work, if the program is properly promoted and the basic ideas are accepted and acted upon by the public. Wise co-operation is the watchword!

Housing, however, is only a small part of the great problem of recovery. Even Mr. Moffett pointed that out in mentioning the necessity for rehabilitation of factories and the replacing of obsolete machinery. Housing has made rapid strides recently but in other fields we see strong evidences every day of better business throughout the country. And since New York has been criticized as the gloomiest part of the nation, perhaps it is pardonable for us to add that we have long since turned the corner ourselves. This is an encouraging sign as is also the recent experience of automobile manufacturers. Production of automobiles in the United States for March and for the first quarter of the year, according to the Department of Commerce, was the largest for these periods since 1929. March production was, in fact, larger than for any month since April, 1930.

People do have money to spend. This is the significant fact gleaned from the recent experience of the automobile industry. The "demand" needs no explanation for it is a well known fact that the replacement time of millions of cars passed two or three or four years ago. So it is with the demand for articles of common use, comfort, and convenience. Someone recently estimated the present "demand" at 85 billion—an accumulated unsatisfied desire for articles to replace those long since worn out, which replacement, had these been normal years, would have occurred once, twice, or even three times since 1929. The 85 billion may have been an arbitrary figure, either too high or too low, but all are agreed that the actual "demand" is far up in the tens of billions of dollars.

The Manufacturers Association estimates that "close to 20 billion dollars in expenditures . . . is pent up in the field of factory expansion, renovation, and rehabilitation alone." As for wholly satisfying this almost universal need for replacements—the job would without doubt keep all our factories busy for years if wise co-operation could but make that demand clamor loud enough. For necessities and even luxuries there is now available more money than there has been for years. Cars are being bought in large numbers; homes or home improvements can be financed easily, as Mr. Moffett explains; and cash can be obtained to finance business, industries, and all the many things we need. We have seen, however, that recovery is a plodding horse, not a thoroughbred racer; and the trouble is that we have been so unbelieving that we have kept him reined in. Isn't it about time to give him his head?

Big Navy?

"A SMOOTHLY functioning majority beat down repeated attempts of big Navy opponents to hold up new ship construction . . ." Big Navy? Please, *please*, explain what is the linkage in the minds of newspaper correspondents when they use the phrase as in this statement taken from a New York newspaper. The reporter was discussing passage by the House of the 457,805,261-dollar bill to build our Navy to Treaty strength. By the terms of that bill we are: to construct one aircraft carrier, two light cruisers, three destroyers over 1500 tons each, twelve destroyers not over 1500 tons each, six submarines; to have 555 new planes, 282 of which will be replacements; and to add sufficient personnel to bring Navy enlisted strength to 95,000, commissioned officers to 8176, and Marine officers to 1074.

It is an easily verifiable fact that these ships are well within the limits of all treaties into which we have entered with other nations. Their total, indeed, falls considerably below the ratio, in respect to one signatory nation, which was assumed at the Washington conference in 1922. After that treaty was consummated, our destruction of enormous tonnage and our failure to plan or build ships was construed as weakness, so in 1927 at London the ratio which most people thought would rule for smaller craft was changed. Washington and London both accepted a relatively lower standing because of Japan's *fait accompli*. What Washington and London now hope to do is to force consideration of real limitation of armaments; and the upbuilding of our Navy to Treaty strength will undoubtedly help. Nothing is farther from the thoughts of American "Big Navy" men than the idea of beginning a disastrous era of naval building competition.

The increase in personnel is desirable for the self-same reason: to improve efficiency to the point where the Navy, in toto, can force a hearing of the plea for limitation and peace. In recent years our Navy has been faced with the necessity of operating with a reduced personnel, for economy's sake, and has suffered accordingly.

We wish, therefore, some bright newspaper correspondent would give us a usable definition of the words "Big Navy" as they apply it glibly—with apparent intent to sensationalize their reports—to the men whom thinking people believe are rendering a service to the cause of peace.

Headlights on the Highway

THE summer months are notorious for increases in the number of motor-car accidents, partly because of the greater number of cars on the highways, and partly because of the carefree attitude of many drivers as they speed blithely along on holiday bent. Perhaps "careless" should be substituted for "carefree," because so many of the horrible catastrophes of the highway are caused by nothing more or less than downright carelessness. Long hours of daylight and pleasant weather tend to make people less thoughtful of the condition of their cars, just so long as they take them where they want to go.

We have written before in these columns of the dangers that arise when car drivers fail to pay attention to small but important details, particularly to the proper lighting of their vehicles. Potential murder lurks behind the wheel of the car that roars along the highway with only one headlight burning. Unlighted tail-lights all too often are the direct cause of fatal collisions. And it is the careless driver who operates his car with such things wrong. These drivers must be curbed. Stricter enforcement of existing laws will help, but essentially the remedy lies in the education of the drivers themselves. They must be compelled to carry spare bulbs for their lights and must constantly be alert. When you are driving a motor car, you are directing a vast amount of power that can become an engine of instantaneous destruction. You would not feed poison to a fellow man: Don't risk his life by operating your motor car with improper lights.

New Light on Ancient

Iron, Glass, the Arch, Bath Rooms, Found to Have Been in Use Far Earlier Than Formerly Supposed . . . 4500 Years Ago . . . A Surprise

By H. H. SLAWSON

SURPRISING discoveries made in the Near East, by archeologists from the Oriental Institute of the University of Chicago, have thrown new light on the technical progress of mankind in the 3rd Millennium B.C., and lead to the conclusion, expressed by Dr. Henri Frankfort of the Oriental Institute, that "man's mastery over matter progressed farther in early dynastic and Akkadian times than is often believed"

Among the results of excavations in the Tigris valley near Baghdad, Professor Frankfort reports (1) the discovery of glass dating from 2600 or 2700 B.C.; (2) the discovery of evidence that terrestrial iron was employed for weapons before 2700 B.C.; and (3) the discovery in a private house of four arched doorways, three of which were completely intact.

Although Professor Frankfort's account of these finds has been published for some time [Since 1933—*Ed.*], these three important additions to our fund of knowledge of technology 4500 years ago have somehow been overlooked by the scientific and technical world.

IT was while excavating at Tell Asmar, site of the ancient city of Eshnunna, 50 miles from Baghdad, that the startling finds listed above were made. In the ordinary run of a day's work in sifting the debris of the ruined city, a small cylinder-shaped object was turned up. Scratched by a diamond in a hasty test, it was indicated that this might be glass, and this was later confirmed by more exact examination. The glass is extremely clear and shows few air bubbles, while, as Professor Frankfort reports, characteristic conchoid fractures are in evidence. The professor recalls that opaque glass was fairly common in the middle of the 2nd Millennium, but that clear glass was not introduced before the Roman times.

The bronze handle for a dagger, mentioned in the article. The iron blade had rusted away long years ago

Horace C. Beck, specialist, to whom the object was referred for thorough study, reported that "if the glass really dates from 2700 or 2600 B.C. it is very surprising. Clear blue glass of a very similar color has been found in the Mediterranean, but it shows much heavier corrosion and it is not older than 800 or 1000 B.C."

Mr. Beck repeated the diamond test, also others, on a microscopic chip from the cylinder. He found its specific gravity to be 2.463 and its refractive index about 1.515. "The specimen from Tell Asmar," his report continues, "appears to have been modeled or moulded to its present shape and has not been cut out of a solid block. The glass is very pure; it has a few small bubbles, but is surprisingly free from striae or inclusion of quartz or dirt. Without spectroscopic analysis it is impossible to say for certain what material was used, but I should think the alkali was probably soda. The coloring may have been accidental, as it is pale. The clearness of the blue suggests that it is due to copper and not iron."

Referring to the discovery that iron was in use 45 centuries ago, Professor Frankfort says: "The most unexpected discovery made was that iron was used for tools before 2700 B.C., more than 1500 years before the day when the first iron dagger known was sent, presumably by a Hittite king, as a present to the youthful Tutenkhamon of Egypt."

On the afternoon of January 25, 1933, the pick of a native workman struck a pottery jar built into the wall of a temple structure amid the Tell Asmar ruins. The jar was brim full of copper utensils, including 60 bowls, four lamps, two bottles, four daggers, a drinking tube, and other objects. The conclusion was drawn that the hoard probably represented a service for a banquet of ritual significance held in the temple, and the question was raised, Was it stolen or hidden from the enemy?

ONE of the objects to which only casual attention was given when the contents of the jar were first inventoried was a bronze handle for a dagger, its perforated openwork construction being of unusual design. Later examination of this handle showed traces of rust in the slot where the tang of the blade had been inserted. Tests of this rust revealed that iron was present in some form.

The dagger handle was referred to Professor Cecil H. Desch, of the University of Sheffield, at Sheffield, England, for further examination. In addition to the original bit of rust Professor Desch found, inside the handle, a lump of similar material, too large to fall through the perforations.

"On analysis," he reported, "this proved to be rusted iron, converted, as usual, by long contact with the earth, into a hard, magnetic, crystalline mass. The position in which it was found leaves no doubt that the blade of the dagger was of iron. Moreover, analysis shows that the iron is free from nickel and is therefore not of meteoric origin."

Professor Desch refers to analyses

All Illustrations courtesy The Oriental Institute

The window at Tell Asmar, mentioned in the text, and one of the four arched doorways. This house was built as a residence nearly 5000 years ago

TECHNICAL PROGRESS

made by him of other iron objects found at Ur and Kish in Mesopotamia, whose high nickel content showed them to be of meteoric origin, and concludes: "The occurrence of an iron object of terrestrial origin at such an early date is most striking and of the first importance for the history of ancient metallurgy."

Professor Frankfort, in further discussion of the discovery, admits that it is difficult to explain the fact that iron was smelted and used for tools so early. "Even in the time of Amenemhet III (about 1820 B.C.)," he says, "it was so rare a metal that a ring of gold found in a royal tomb at Byblos contains a small inset of it, as though it were considered the rarer and more costly metal."

PROFESSOR Frankfort recalls that Transcaucasia and Armenia had been great iron-producing centers in classical antiquity. He mentions finding weapons and tools of iron in tombs which had been assigned to the Iron Age, after 1000 B.C., and continues: "Certain objects in the tombs, especially the pottery, argued against the later dating. So it seems to me the iron blade of our knife must have been an importation from the north and that iron was very occasionally used in Armenia during the 3rd Millennium B.C., but not exported, because it was less serviceable than well-hammered copper or bronze."

Supporting this last statement he cites the heroes of the Edda, who had to stop every now and again in the middle of a combat to straighten out their iron

Dr. James H. Breasted, the noted archeologist and Director of the Oriental Institute. Note the arch

swords which had become bent. Concluding, he says: "The spreading of the use of iron in the second half of the 2nd Millennium would then be due, *not* to the discovery that iron could be obtained (a knowledge which we presume to be much older) but to the discovery of new methods for casting and working that metal."

Private houses of the period of Sargon I have not been excavated to any extent prior to the time when the Chicago explorers dug into the wreckage at Tell Asmar. The investigations of the Oriental Institute resulted in much new and important knowledge of the architecture and the domestic life of this period.

One of the finds was a window in the wall of an anteroom in one of the private residential houses. "It is the first window in the history of Babylonian excavation to be found completely preserved," asserts Professor Frankfort. It measured about a foot square, and the lintel, made of five stout sticks, still survived, in the shape of a carbonized fibrous substance which clearly preserves the structure of the wood.

The central room of this house had four arched doorways, three of the arches being still completely intact. None of the doors was more than five feet high and the explorers had to stoop to enter.

"That the arch was used at all in this early period is new knowledge," says Professor Frankfort. "Its discovery was as unexpected as that of the window."

AMONG the dwelling houses evidence was found to support the conclusion that the people of the Sargonid era were not unfamiliar with the bath. Describing one of the best-preserved bath rooms excavated, Professor Frankfort explains that the floor was covered with bitumen. A depression in the center of the room held the sherds of a large pot —no doubt a water jar. From one side of the room ran a drain of baked brick which turned outside and disappeared under a bitumen drain. "This room," he says, "contained all the essentials for a bath room. Since we found other bath rooms in other houses . . . we can safely say that the bath was an essential element of the Sumerian dwelling house."

In one of the temples uncovered, the explorers were impressed with "the elaborate arrangements for sanitation." No less than six toilets and five bathrooms were uncovered. Two of the baths were in an inaccessible part of the temple and were provided with individual cesspools. The remainder of the plumbing equipment was connected to drains which discharged into a main sewer, one meter high and 50 meters long. This was vaulted over with baked brick and ran along the outer wall of the building beneath the pavement of a passageway.

A toilet drain, showing better ideas of sanitation nearly 5000 years ago than some civilized peoples (not to mention names) seem to have today

In tracing one drain the investigators came upon a line of earthenware pipes. One end of each section was about eight inches in diameter while the other end was reduced to seven inches, so that the pipes could be coupled into each other just as is done with drain pipes in the 20th Century A.D.

Another adjunct of contemporary civilization, the rain barrel, seems to possess considerable antiquity, judging from Professor Frankfort's finds. "Drip pavements" of baked brick were commonly laid at the point where the water, falling from earthenware eavestroughs, would strike the ground. One such pavement, says Professor Frankfort, "contained three large jars, obviously placed so that they could receive jets of water."

It was in 1919 that the Oriental Institute, under the direction of Dr. James H. Breasted, began its epic effort to trace the rise of man in Egypt and the Near East. The work has continued unabated for 16 years and the many startling discoveries made by the scientists have forced plentiful modification of previously held conceptions about the ancient world.

TELEPATHY AND CLAIRVOY-

By J. B. RHINE, Ph.D.
Associate Professor of Psychology
Duke University

MEDIUMSHIP is still a puzzle to psychology, although it is now fifty years since William James discovered the famous Mrs. Piper and made a study of her phenomena. Many psychologists here and abroad have interested themselves in these strange cases, but no clear understanding has yet been arrived at. Much has been learned, but the medium as a phenomenon is still a mystery. Some of the ablest minds of the past half century have attacked it. Also there has been no lack of material for study. The Spiritualists have supplied mediums in plenty. Numerous, laborious, and voluminous have been the reports of studies made on these mediums. Why have they failed in their goal?

The British trance medium, Mrs. Eileen J. Garrett, in normal waking state *(left)* and in a trance *(right)*. Both she and her "spirit control" scored approximately the same in tests for telepathy and clairvoyance, conducted under rigid conditions

Most investigators of the medium have naturally set to work to solve the problem of the spiritistic nature of mediumship. The medium claims spirit contact and communication, and this claim is thus made the immediate point of attack by the investigator. The problem is surely a legitimate one, but it is just as surely not logically the first problem to be attacked. Like many other problems in nature, it cannot be solved without being let alone until something else that is naturally preliminary is first solved. For example, it would not be legitimate to ask and investigate who killed John Jones until it is first established whether or not John Jones is dead.

THE spirit theory of mediumship is, in my judgment, to be considered as a possible one only after it is first clearly established that the natural powers or abilities of the medium either in trance or awake are incapable of explaining all of her performances. Then, and only then, may we properly consider hypotheses involving external agencies such as spirits, Universal Mind, and the like.

The difficulty for many people with this more logical approach to the problem of mediumship is that we seem to them to be ignoring or even opposing the spirit hypothesis, in thus setting it aside for an exhaustive exploration for natural gifts that might explain the mediumistic performances. They fear, perhaps, that we may find out it is not necessary to assume spirits to account for the results. But unless we are ready to take the consequences of an investigation, regardless of our wishes or expectations, we are not ready for scientific exploration.

Actually, however, there is no hostility to the spirit hypothesis in this approach. As a matter of fact, it is the only way I see of really demonstrating it securely, if it can be demonstrated. That is, if there is foundation for it in reality. It must also be kept in mind that the phenomena of mediumship are not the only possible sources of evidence bearing on this hypothesis. In the minds of some, there are probably other better sources. But this question does not properly arise in a study of a medium unless and until it is shown that her own capacities are unable to account for the results.

In a series of studies made in the psychological laboratory at Duke University over a period of more than four years, it has been found that many normal people possess capacities to perceive objects not present to the recognized senses, and to perceive the thought impressions of others without sensory cues. These modes of Extra-Sensory Perception (E. S. P.) are called respectively Clairvoyance and Telepathy. In a huge number of tests, now numbering several hundred thousand separate trials, it was shown, among other things, that telepathy and clairvoyance are perfectly natural abilities, are related to certain other mental processes that are better known, and that they are closely related to each other. For example, all the better subjects tested showed both the capacities of telepathy and clairvoyance in roughly equal measure.

AFTER the first 90,000 trials (approximately) were made, a volume was published reporting the work in detail. (*Extra-Sensory Perception*, Boston, 1934.) A lengthy illustrated review of it appeared in SCIENTIFIC AMERICAN, July, 1934, written by my friend and tutor, the late Dr. Walter Franklin Prince.

After the Duke experiments had well passed the 100,000 mark with normal subjects it was decided to apply the procedures to a medium. We were interested not only in the natural abilities of mediums, but also in getting more data on the range of E. S. P. in different types of personalities and in the different personality states of the medium.

We were fortunately able to secure the services of Mrs. Eileen J. Garrett, a well-known British medium, who had worked in other psychological laboratories before, and who had the reputation of being most co-operative in laboratory work. We found her entirely willing to enter into any experiment proposed. Her control personality, Uvani, the Arab "spirit," as he claims he is, who appeared in the trance condition, was not so willing as Mrs. Garrett, but he did comply (reluctantly) with the requests made. He disclaimed any tele-

ANCE IN A TRANCE MEDIUM

A Logical Approach to a Study of the Phenomenon of Mediumship . . . How Tests are Made . . . "Spirit" no Better Telepathist than is the Medium

pathic or clairvoyant powers for himself, saying these belonged to the "instrument" or medium.

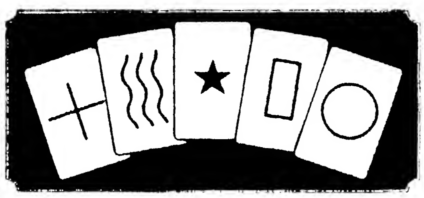
In the three weeks of intensive experimentation with Mrs. Garrett, she made 16,000 trials in E. S. P., nearly 12,000 being tests for clairvoyance, and the rest for telepathy. Only 1575 of the total were obtained from the Uvani personality due to his reluctance.

The tests themselves were simple. For clairvoyance we used packs of 25 cards, containing five each of five different symbols: circle, star, rectangle, plus sign, and wavy lines (see illustration). These packs were shuffled several times, were cut, and then put face down before the medium on a table, in normal light. At first, as she called them, she was allowed to hold the pack of cards in her hand, removing them one by one, and putting them down, faces unseen, on the table again. At the end of the run the calls were checked. After success was reached under this condition, the cards were next left lying on the table and were removed by the observer as the medium called the top one.

THE next advance consisted in taking the cards over to another room, out of sight from the medium. Over a third of the work was done at this distance. In all the clairvoyance tests, no one knew what the card was before it was called, and no one looked at it until the end of the run of 25 calls. The calls were recorded and the cards checked against them while both observer and subject watched both card and call record. When they were in different rooms the observer signalled the medium with a telegraph key when the card was removed and the next one was to be called.

In the telepathy tests the same five symbols were used but no card or other objective record was present until, after each call, the symbol of which the agent or sender was thinking would be recorded by him without naming it. In some series he would merely check the successes of the percipient or receiver; in some, a double record was kept, one at each end of the process; and, in a few others, packs of cards were used by the agent as the basis of his order of choices of symbols. That is, he would take the top card, turn it over, and while looking at the card-face would signal the percipient to make a call. This was mixed or undifferentiated E. S. P.

What results did the medium produce? It is not so simple to state these, because this involves mathematical evaluation. True, common sense supports the mathematics, but it does not go very far in dealing with the results. The whole 16,000 trials gave 4018 hits for both phases of E. S. P. and both personality states. Now chance alone would be expected to give 1/5 of 16,000, since there is one chance in five of getting a hit with a five-suit pack of cards with every trial. This gives 3200 hits as the most likely figure from chance alone



One of five similar sets of cards used in the telepathy tests described

and leaves a gain or positive deviation of 818 or over 25 percent above the chance expectation. Chance results vary, it is true, but we can compute its probable range; and this deviation is so far beyond the widest limits given by statisticians to chance results as to leave no argument. The odds against the chance theory indicated by these data would take a number of at least 60 digits to state. Odds in three-place values, however, are enough for the statistician.

This reports the totals of all the trials actually made, without omission. Fuller details are given in the original report which appeared in the December number of *Character and Personality* (Duke University).

Stated more simply, perhaps, we have in the total of 640 runs made by Mrs. Garrett an average of 6.3 hits per run of 25. Now, an average of 6.3 for only 18 runs is mathematically significant. That is, it passes the arbitrary criterion used in experimental science for deciding whether or not a principle is shown by a set of measurements. It means that the odds are 143 to one that the results are not due to chance. But we have 640 runs averaging 6.3 or 35 times the 18 required for satisfying the accepted criterion. So we may all feel comfortably assured that "chance" did not produce the results obtained with Mrs. Garrett.

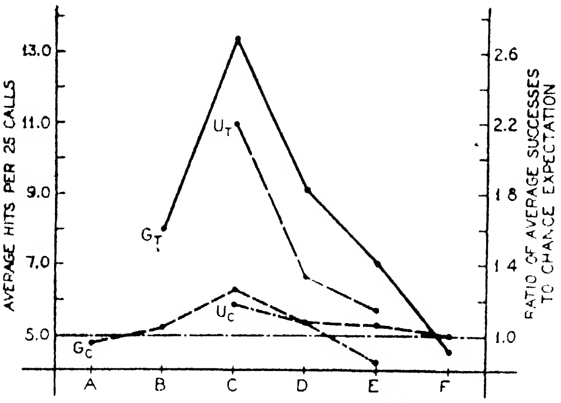
The table on the next page indicates the score averages for the different conditions, clairvoyance and telepathy, for each personality. Also, in order to show the course of development of the scoring, I have grouped the results together in six sub-groups representing the data of three days each (with one exception of two days). Note that Mrs. Garrett began with clairvoyance tests and for the first three days did not get above chance average. In the next three, group B, she got only a little above this in clairvoyance, but on telepathy she did very well with an average of 8.0.

With group C the scores reached the top. From that point on they declined as is shown in the graph. In all four curves point C is the high point. Here too, Uvani, the trance personality, first entered the tests. He started on about equal footing with Mrs. Garrett; he did not begin at the bottom as she did.

The most noteworthy fact in both the graph and the table is the relatively close similarity between the two states of personality, Mrs. Garrett and Uvani. The parallel continues even beyond these totals given here down into details.

THIS close paralleling is the more striking since the scores in the two types, telepathy and clairvoyance, are so wide apart in both cases. That is, the peculiar difference between the clairvoyant scoring level and that for telepathy, as shown by Mrs. Garrett, is found equally striking in the Uvani personality, although it is a feature in which she is different from my other subjects.

The chief point of interest to many will be the suggestion which these results give in the parallel just cited, that Uvani and Mrs. Garrett are essentially the same person, at least in the capacity of E. S. P. It is true that Uvani warned us that he did not possess these powers, that only the medium had them. But how could the "spirit" he claims to be commune with other minds except by telepathy? How could he know all he claims to know of things without clair-



Comparison of scoring rates in telepathy (T) and clairvoyance (C); Uvani (U) and Mrs. Garrett (G)

voyance? Lacking sense organs, as "spirits" must, how function without E. S. P.? Yet it would be hazardous on this evidence to be too sure about Uvani. This is only a beginning.

The next point, and perhaps that of the most consequence, is that, since both personality states of Mrs. Garrett showed strong positive evidence of E. S. P., this becomes a potent explanatory factor in dealing with her mediumship. There has long been a telepathy hypothesis. Now we can be safe in applying this hypothesis to Mrs. Garrett's performances and in adding to it the sister-capacity of clairvoyance. Her mediumistic utterances must pass clearly beyond the explanatory range of these natural capacities she has shown in these controlled tests, if they are to contribute to the spirit hypothesis. This means, probably, that they must show evidential forms not yet developed.

On the other hand, the evidence of E. S. P. has a positive bearing on the spirit hypothesis. Without E. S. P., such existence would be inconceivable. It gives mind a self-sufficiency it could not get along well without. Only through E. S. P. could mind function without its body.

A further point of interest that appears in these results is the fact that Mrs. Garrett stands, at her best scoring period, about on the level with my other good subjects. She gave an average of close to 10 hits per run of 25. This seems to be a fairly representative average score for subjects at their best. Mrs. Garrett was next to the best subject we have found in telepathic work, but was rather poorer than most subjects in clairvoyance. She felt the monotonous dullness of the routine more in clairvoyance tests.

Finally, let us take up a few of the more likely questions that may occur to the critical reader and answer them briefly.

First: Many wish to know how the subject gets the image. That is, what does introspection yield. It gives almost nothing, and apparently the process is completely unconscious.

Second: What are the necessary conditions for bringing out such capacities? The most important is interest. Spontaneous enthusiasm is best. A certain degree of confidence is necessary. Concentration of attention is required by most, but this varies. Relaxation and abstraction from all save the task is desirable.

Third: How can we know the agent and percipient in telepathic tests do not merely have similar habits of order in selection of symbols? We have the agent vary by an irregular system made up at the time. This has been checked in some of the cases of this study. Best, perhaps, is the cross-check control. We check one run of the agent's record with a different corresponding run of the percipient's record. We have found only the chance expectation in such tests.

Fourth: How do we know that the cards are not merely inadequately shuffled? By checking one run of card records against its successor. This showed no significant persistence of order through the series, and yielded close to chance expectation.

Fifth: Is it possible that agent and percipient are in collusion? There were in the tests with Mrs. Garrett alone six different agents functioning. Most of them were either assistants or staff members. I served as agent in a significant series of runs myself.

Sixth: Is the mathematics of evaluation beyond dispute? Yes, among those trained to understand it. It has been used in this way in several branches of science, and in this particular field has served for nearly 50 years. It has been given attention by several statisticians in connection with this work. We have made over 100,000 empirical trials in checking it, and are fully satisfied as to its dependability. It leaves "no chance for chance" as a theory applicable to these results. But one need not be much of a mathematician to see that Mrs. Garrett's best score of hits in 100 trials in telepathy, two rooms from the agent, is too good for chance.

Seventh and finally: What about the old question of sensory cues? This is answerable for the card work by the 3725 trials made with the cards out of the room, with a wall between card and percipient. These yielded a slightly better score than with the cards in the room. The telepathy done with distance was likewise better than it was with the agent and percipient in the same room. Here too they were invisible to each other when in different rooms.

What is left? The hypothesis of E. S. P. This is not very definite. We know too little to define it in more than non-committal descriptive terms. But it seems to be a natural, mental phenomenon, apparently not a radiation process, not involving a sense organ, and possibly independent of spatial restrictions. It is a phenomenon that challenges many fields and will perhaps stretch across many boundaries in the course of its scientific development.

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Readers who wish to refer to other articles in SCIENTIFIC AMERICAN *on the subject of telepathy will find the following list of assistance: March 1932 (page 135); March 1933 (page 140); April 1933 (page 211); May 1933 (page 264); June 1933 (page 324); July 1933 (page 10); August 1933 (page 66); September 1933 (page 108); October 1933 (page 152); November 1933 (page 200); February 1934 (page 64); July 1934 (page 5).* The Editor.

SUMMARY OF RESULTS OF TESTS FOR EXTRA-SENSORY PERCEPTION WITH THE MRS. GARRETT AND UVANI PERSONALITIES, APRIL, 1934

Date	Group	Normal Personality						Uvani Personality					
		Clairvoyance			Telepathy			Clairvoyance			Telepathy		
		Trials	Hits	Av. per 25	Trials	Hits	Av. per 25	Trials	Hits	Av. per 25	Trials	Hits	Av. per 25
10, 11, 12	A	825	162	4.8	.....	.....	....	....	.....	...	.....	.....	.....
13, 14, 16	B	1,475	307	5.2	*575*	*185*	*8.0*	.....	.....	.....	.....	.....	....:
17, 18, 19	C	*3,525*	*888*	*6.3*	625	*336*	*13.4*	300	71	5.9	*100*	*44*	*11.0*
20, 21, 23	D	2,850	621	5.4[1]	*1,025*	*374*	*9.1*	400	87	5.4	75	20	6.7
24, 25	E	800	171	5.3	*875*	*248*	*7.1*	300	51	4.3	400	91	5.7
26, 27, 28	F	1,425	284	5.0	425	78	4.6	.....	.....	.....	.....	.....	.....
Totals all 17 days		*10,900*	*2,433*	*5.6*	*3,525*	*1,221*	*8.7*	1,000	209	5.2	*575*	*155*	*6.7*
Totals first 12 days		*8,675*	*1,978*	*5.7*	*2,225*	*895*	*10.1*	700	158	5.6[2]	*175*	*64*	*9.1*

Grand total *16,000 4,018* (av. *6.3*) +818 ± 34.1 X = 24.0.

[1]X = 3.5.

[2]**Barely significant, when treated in daily series and combined by taking mean square of independent X-values. But I regard the finality of this formula as still in reasonable question.**

From *Character and Personality*

HOW BRIGHT IS A LIGHTNING BUG?

By W. A. PARLIN, Ph.D.
Professor of Physics, Dickinson College, Carlisle, Pennsylvania

THE organ which produces the light in a lightning bug or fire fly is located in the last two segments of the abdomen. These show clearly above, at right. It consists of a fatty tissue containing a large number of tiny air tubes. When the fire fly is stimulated or excited, air rich in oxygen is released by these tubes, which unites with a chemical substance, and a slow combustion or oxidation process takes place. The ratio between the intensity of the light thus produced and the amount of matter oxidized is the largest known to science, the efficiency being better than 95 percent. The best man-made light is less than one percent! Most of the energy in the latter case is radiated in the form of heat.

Under a high-power microscope, the radiating surface of the fire fly presents a gorgeous display of pyrotechnics. After the eye becomes dark-adapted, one sees a soft glow, broken here and there by bright flashes at irregular intervals, and climaxed finally by the brilliant flash coming from the whole surface.

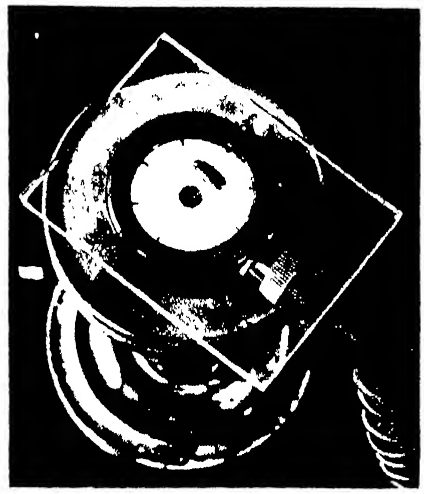
The easiest way to measure very small light intensities is by means of the photo-electric cell, developed during the past few years for the purpose of transforming light energy into electrical energy. This can then be measured directly with a sensitive galvanometer or micro-ammeter, these delicate instruments being capable of indicating currents as small as the one hundred millionth part of an ampere.

One form of the photo-electric cell, the Weston photronic cell, is especially convenient for measuring the intensity of fire-fly flashes. These cells are of the self-generating type, requiring no external circuit voltage. The flat glass surface and projecting rim of the photronic cell serve as the floor and side wall of the enclosure for the fire fly, and a small piece of wire gauze for the top completes the miniature cage. A shield of black paper or other suitable material must be placed over the cell to protect it from any external light.

The photronic cell is connected directly with a very sensitive ballistic galvanometer. A switch is necessary to cut the photronic cell from the circuit, in order to prevent the effect of a second flash occurring before the galvanometer deflection for the first flash is completed.

THE total energy of a given flash will be proportional to the maximum swing or deflection of the ballistic galvanometer. Single flashes from the same fire fly vary over a wide range, hence a series of readings are taken for each of several fire flies, and the average deflection for each series is determined.

A diaphragm is now placed over the sensitive surface of the photronic cell, having an opening approximately equal to the luminous area of the fire fly. A standard lamp of known candle-power is placed above the cell, at such a distance that a flash from the lamp will produce the same deflection as that produced by the fire fly. The light intensity of the standard lamp and of the fire fly are now the same at the surface of the photronic cell. This intensity is given by the ratio of the candle-power of the standard lamp to the square of its distance from the photronic cell. Finally, if we know the distance of the fire fly from the sensitive surface of the cell, its candle-power can be determined. The average brightness of the fire fly is about one fifteen hundredth that of a standard candle.



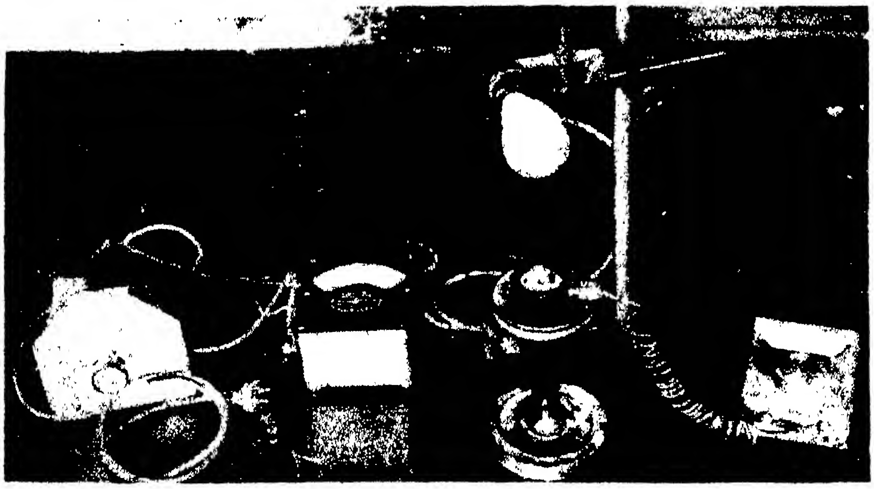
The miniature cage which records the flashes of the fire fly, also the photronic cell (Weston Electrical Instrument Corp.). To permit the insect to be photographed clearly, a glass plate has been substituted for the wire gauze mentioned in the text, for keeping the bug in the cell

If we connect the photronic cell to a radio amplifier, the flashes can be made audible and, by adding a magnetic counter to the circuit, a record of the number of flashes can be had independent of an observer.

Colonel Gorgas, at the time of the Spanish-American war, used the light from a bottle of fire flies to carry out an operation.

Although the fire fly is a very efficient source of light as far as mere visibility is concerned, the fact that its light is concentrated in one color makes it very poor as a general illuminant. The colors of objects illuminated by it would be distorted about the same as by the mercury arc.

How the fire fly can radiate "cold light," free from the enormous amount of heat which is present in all man-made sources of light, is a problem which has baffled science for many years, and its solution will revolutionize our lighting industry.



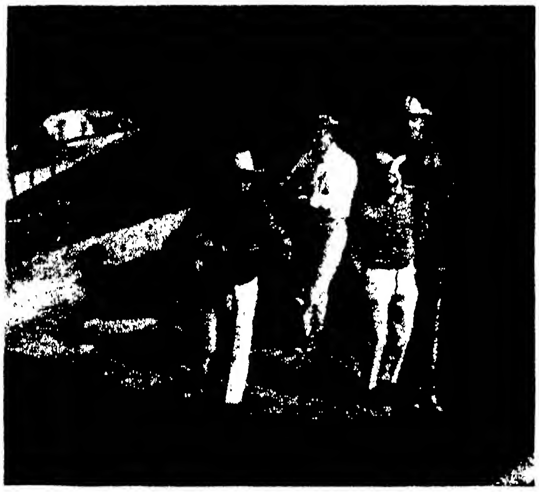
The assembled apparatus used for measuring the intensity of the fire-fly flashes

IS THE EXPOSURE RIGHT?

Advanced Amateur Photographers Will Find Many Uses For Exposure Meters . . . When And How To Use Them . . . Outdoors . . . Indoors

By JACOB DESCHIN

EXPOSURE meters were created and are being widely used on the theory that if a picture is worth making at all, it is worth taking a little trouble to do the job right. Dedicated to the perfect negative, without which no perfect print or enlargement may be had, exposure meters are used by professional and serious amateur alike, for light intensity is a deceiving quantity which even the experienced photographer cannot always evaluate correctly.



The exposure for this fine example of theater photography was determined with a photo-electric exposure meter. 1/60 second at stop f/2

The good negative is that one in which there is an orderly progression of tones from the deepest shadow to the brightest highlight, the whole giving a faithful reproduction in monochrome of the appearance of the subject photographed. There are, of course, many remedies for the many ills of faulty negatives, such as intensification for under-exposure and reduction for over-exposure, the use of "contrast" papers for "flat" negatives and "soft" papers for "contrasty" negatives, and the many tricks and dodges used in developing the poorly exposed negative or in making and developing the final print or enlargement. But like all remedies they are, after all, merely makeshift and cannot be quite so satisfactory as a well-done performance in the first place.

There is no greater thrill in all photographic experience than a good negative of a good subject printed on a paper of suitable surface and of the "normal" grade of contrast, which retains all the gradations of the light reflected from the subject at the time it was photographed.

If the amateur thinks that such a negative is beyond his abilities and that it is only the professional who can achieve such results, let him consider the fact that if he uses good negative material he can give as many as five different exposures for the same subject and get a correctly exposed negative every time. This is due to the fact that good film, and there is good film aplenty, has a tone range of 150 to 1, meaning that it has 150 degrees of brightnesses from the highest highlight to the deepest shadow, and that since most subjects have about five separate tones and very rarely do they exceed thirty, it is possible, for instance, to give exposures varying from 1/10th to 1/50th of a second and each one will be correct. The difference in the longer exposures will be an increase in the over-all density, though the relationship of the various tones to each other will be the same in each negative.

The choice of exposure time, then, depends on the type of work, the effect desired, the kind of paper to be used, and other factors. Given half a chance, the exposure meter will provide the photographer with the ability not only to make adequate exposures but also to choose the particular type of exposure he wants.

Exposure meters range all the way from the simple slide-rule with tabulated figures indicating various exposure data to the most accurate instrument in its field on the market—the photo-electric type. All meters must take into account the speed of the film material used—that is, the minimum exposure that may be given in order to produce a good negative—and the luminosity of the subject, or the capacity of the latter to reflect light. For photography is, fundamentally, the recording of light reflections. Using as a basis an indicated figure—arrived at by measurement of the light intensity by means of the meter—and guided by the film speed figure, the proper shutter speed and lens opening are found. The exposure selected then depends on the darkness or lightness of the principal part of the subject being photographed, the depth of focus desired, provision for increase in exposure necessary because of the use of filters, and other special factors.

THE simple slide-rule type of meter, which indicates exposures to be given various types of subjects under different degrees of sunlight, depends entirely on the judgment of the photographer as to whether prevailing light conditions at a specific time of day fit the classification of the meter. The great latitude of modern film material, greater in the slower film than in the "super" type, makes it possible for him to veer considerably from the correct exposure and still get a good negative. But these exposures are meant for average conditions and subjects and generally for the brightest periods of the day. Special conditions, such as close work or where it is desired to show texture, are out-

In order to give adequate exposure to the dark subject, the exposure meter showed that the lighter background must be over-exposed

side the accurate range of the slide-rule meter.

A second type of meter, known as the "tint-paper" type, is not so generally used in the United States. With this meter, the amount of light falling on the meter is measured by a sensitive paper which takes a certain length of time to darken, depending on the strength of the light. This time duration is then used as the basis for determining the necessary exposure.

In the type of pictorial photography shown in these two illustrations, the silhouettes "make" *(continued below)* **the picture. Therefore, highlights become more important, and exposure must be governed according to them**

The visual or "extinction" meter consists of a tubular eye-piece arrangement by which the strength of light reflected from a subject is measured by holding the eye close to the eye-piece and deciding the dimmest figure in a line or circle of numbers at the end of the tube that can be read clearly and without eye strain. This figure is then used as the basis for figuring out the exposure on the slide-rule on the outside of the tube.

THIS type of meter enjoys wide popularity and many happy results have been obtained through its use, but this also gives only an average reading and will not do for the exacting job. Owing to variations in the eyesight of different users of the meter, one photographer may get a different reading from another. Every precaution must therefore be taken to avoid eye strain and thus give the eye every chance for reading the numbers under normal conditions. The advice is never to take a reading when eyes are dazzled; hold the eye-piece firmly to the eye so no false light can enter; when coming indoors from a sunny outdoors, or the other way about, wait a short time until the eyes have become accustomed to the new light intensity.

The photo-electric meter is the last word in exposure calculators and by far the most efficient—albeit the most expensive—instrument on the market. Its base is a form of light-sensitive cell. Variations in the strength of the light reflected from the subject to the cell are indicated by the movement of a pointer, which indicates the basis for calculating the exposure to be given. The meter is pointed toward the most important part of the subject or that part of it which should be most carefully measured because its correct exposure is necessary to proper over-all exposure. In pointing the meter it must be remembered that the "angle of view" of the meter includes a "cone" of light embracing an area of about 50 degrees, which is that of the average lens. Portraits, small objects, reproductions, and similar subjects require as close an approach as possible, taking care not to obscure the subject. In taking outdoor pictures, care must be exercised that the meter is held at a slight angle so that the sky is excluded from the area of the "cone" covered by the meter. Otherwise a much higher reading will be had than that justified by the subject.

Of course, there are certain cases in which a meter reading would be ignored, if a meter were used at all. There are the "must" type of pictures, such as speed sports snapshots, when wide-open lenses and the fastest shutter speeds are in order no matter what the light conditions. The sports photographer must get his pictures and he will do it even if it means considerable under-exposure. But the independent amateur can take it or leave it. He serves no boss but his own artistic instinct. He will leave speed photography alone when there is insufficient light; he will prefer the soft morning and late afternoon sunlight to the harsh, glaring beams of mid-day; whenever the subject permits he will use the fine-grain, good contrast, slower films with their greater latitude rather than the "super" films with their extreme speed and tendency to flatness and "graininess." Also, since the recording of light reflections is the basis of photography, he will not attempt to take pictures when the light is not interesting, for "flat" lighting, while it will produce a picture, will not usually give a picture to make the heart proud. Contrast, the play of light and shade, is the very soul of photography.

A point about sun-brightness may be helpful: While many amateurs believe that an unobscured bright sun is the brightest photographic light there is, as a matter of fact it is only so when veiled by white clouds. For then the light is diffused into the shadows, whereas in the case of an unobscured sun the shadows are much blacker. Incidentally, the old rule "Expose for the shadows and let the highlights take care of themselves" applies especially in bright sunlight, for under such conditions it is easy for the photographer to be misled into thinking that since everything seems to be so well lighted, the shadows must be too.

OVER-EXPOSURE is better than under-exposure, since the former will produce a print, though it will require longer printing-time than a normal negative would need, while nothing much can be done to improve the negative extremely under-exposed.

In all calculations of proper exposure, the principal thing to be taken into account is that, for the purposes of the exposure, the only light that counts is that which is reflected from the subject being photographed.

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If you have not already obtained the SCIENTIFIC AMERICAN *list of representative miniature cameras available in the United States, giving pertinent data and prices, by all means write for it at once. Ask also for our list of books on photography for the beginner as well as the advanced amateur. Please send stamps for postage.*—The Editor.

IMPOSSIBLE PLANETS

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

RECENT reports from California announce the discovery of four white dwarf stars, doubling the known number of these remarkable bodies.

It has long been known that the Companion of Sirius, and one component of the double companion of the fourth magnitude star Omicron Eridani, were strange objects; for, though of very low real brightness, and hence justly to be called dwarf stars, they are white or whitish in color and presumably much hotter than the sun. But a body hotter than the sun should emit more light per square mile, hence these stars must be small—no bigger, in fact, than several of the planets.

This is not so remarkable by itself, but both of these stars, being double, belong to the rather small list for which masses could be computed, and both are comparable to the sun in mass—the Companion of Sirius being more than 300,000 times the earth's mass, and the other about 150,000. The enormous resulting densities appeared to be incredible until Eddington explained them on the simple supposition that the atoms inside the star were thoroughly ionized—that is, had all the outer parts knocked off them, so that the gas which they formed could be very greatly compressed without their "jamming."

A third star of the same sort was discovered by van Maanen, and another in the Perseus Cluster by Oosterhout. These discoveries were accidental; the astronomers involved were looking for stars of rapid apparent motion in the heavens which bid fair to have large parallaxes. The large majority of these stars are red, but these two turned out to be white.

A DELIBERATE search for more of the same kind has recently been made at the Lick Observatory by Kuiper (whose interesting work on double stars we recently described). The best chance of success was obviously among those stars which have large parallaxes, and are so faint that their spectra have not previously been observed. Working with a small but powerful spectroscope, and also through measures of color, he has detected three more objects which are clearly of the same kind. All are very faint—from the 11th to the 15th magnitude; and have large parallaxes and small distances—from 50 to 60 light-years. In real brightness they range from one one-hundredth to one five-hundredth of the sun's luminosity.

Adams and Humason, observing the spectra of these stars at Mt. Wilson, find them to be similar to one another, and very peculiar. The lines are extraordinarily wide and diffuse, so that only a few of the strongest can be recognized; but there are enough to show that the atmospheres are hotter than the sun's. One more star, whose parallax and real brightness have not yet been measured, has a similar spectrum and is doubtless of the same sort.

It is easy enough to calculate the diameter of a star, if we know its real brightness and its surface temperature. For the present group the latter is rather hard to estimate, as the spectra are so queer. But the values given below are derived from standard formulas. The calculated sizes are more likely to be too large than too small.

Star		Real Brightness (Sun=1)	Spectra	Surface Temp.	Diameter (Earth=1)
Sirius (Companion)		0.005	F_0	7500	3.5
o Eridani (Companion)		0.006	A_0	11500	2.1
van Maanen's star		0.0013	F_5	6000	1.3
Kuiper's stars	1	0.001	A	10000	1.8
	2	0.010	A_5	8500	5.6
	3	0.0015	F_5	6000	1.5
Oosterhout's star		0.018?	A_2	10000	8.2?

The values for the last star are uncertain, as its observed parallax is so small (0".011), that any results calculated from it have a large percentage error. For the others the calculated diameter may be wrong by 25 percent, but it is nevertheless evident that these curious bodies are remarkably similar in size. The average for the six is 2.6 times the earth's diameter, or just about 20,000 miles. Only one of them is twice as big, and none is less than half. For comparison, we may recall that in round numbers the diameter of the earth is 8000 miles, while that of Neptune, the smallest of the major planets, is 31,000.

The densities of the first two stars come out 40,000 and 90,000 times that of water. For the others we have no direct evidence, but they are doubtless also very high.

These remarkable bodies evidently represent one of the standard products of nature. They are hard to find, since they are so faint, but if we could make a complete census of all those in a given part of space—say within 50 light-years from the sun—we would undoubtedly find them to be more numerous than the giant stars which, because of their brightness, almost monopolize our ordinary star catalogs.

WHY should they be so unlike other stars and so like one another; and what stage in a star's possible history do they represent?

It is risky even to attempt an answer to the latter question: yet if we dare to say anything at all about the history or evolution of a star, we can hardly avoid the conclusion that the white dwarfs represent the last stage of senility.

A star is forever being pulled together by its own gravitation. Only the expansive pressure of the hot gases inside it keeps it from collapsing. As this heat leaks out to the surface and keeps the star shining, it is replaced by new supplies. We are sure now that these are drawn from some sub-atomic source—just what, we do not yet know—and are sufficient to keep a star like the sun shining for many thousand millions of years; and we are also sure that, whatever its origin, the supply must be exhaustible. Given time enough—much longer than the past history of our solar system—the internal supplies must wane and the star will inevitably contract, slowly but steadily.

If the constituent particles of the gas were atoms of the type with which we are familiar, there would come an end to the contraction when these were jammed so close together that there remained little or no free space between them; and, at the last, the mass would be about as dense as ordinary solid or liquid matter—somewhat denser, on account of the great pressure. But, inside a star, the atoms are broken up into their own constituent parts—electrons and nuclei—and these last are so exceedingly small that an enormous degree of condensation would fail to "jam" them.

Until a few years ago no one could even suggest where an end would come to this process. But the quantum laws

The Investigation of Three Newly-Discovered Stars of the Companion-of-Sirius Type (the Famous Star That Weighs a Ton Per Cubic Inch) Shows That These Extremely Dense Bodies are Old Stars in the Process of Going Out. It Also Shows That Planets Much Larger Than Jupiter are an Impossibility Anywhere in the Universe

which govern the way in which the electrons are built, shell upon shell, into atoms, apply also, though in a different way, to limit the condensation even of the interior of a star. Given a specific volume of space—say a cubic centimeter—these laws permit the crowding of an indefinitely great number of particles into it, but only upon certain conditions regarding their motions. Nature will tolerate only a definite number of slow-moving particles within this volume; if more are to be admitted, they must be faster-moving. Now the pressure depends on the average energy of motion of the particle; hence, to obtain a great density, demands a high pressure. This is true for an ordinary gas; but the details are different here. For an ordinary gas the pressure remains high, even after every bit of heat (energy of motion of the particles) has been extracted which the laws of nature permit to escape. Moreover, the pressure is now proportional to the 5/3 power of the density—not to the density itself, as in the familiar case. When the particles move so fast that they approach the velocity of light, the formula for the pressure becomes more complicated, but it is accurately known.

To work out just how a star would be built if it were composed of matter which followed this law, is no simple problem, but it has been solved with remarkable mathematical elegance by a young physicist from India, Chandrasekhar, who is now residing in England.[1]

The result of his investigation is that a star of a given kind of matter, and a given mass, after it has lost all the energy which it can possibly radiate away into space and has settled down into the degenerate condition, must have a perfectly definite size and an equally definite internal constitution. For a small mass the central density will be six times the average for the whole star; for larger masses the ratio increases. The larger the mass, the *smaller* will it be when it has shrunk to the limit. (Roughly speaking, its greater power of gravitation enables it to compress itself more.)

For a body composed mainly of the heavier atoms (from carbon and oxygen upward) and of one fourth the sun's mass, the limiting diameter would be a little over twice the earth's. With half the sun's mass it would be 1½ times as big as the earth; if as massive as the sun, its radius would be 85 percent of the earth's. For larger masses the calculated diameter diminishes rapidly, and for 1.43 times the sun's mass there is no longer any limit to the contraction. More massive stars are not subject to this restriction. The reason is simple. In large masses the internal gravitational pressure is very high; to produce this pressure the particles of the gas must be moving fast, and when the calculations are made it turns out that their average motion will be so fast that the mechanism will no longer fall foul of the quantum restriction, however far it contracts.

All this sounds pretty speculative. But it is based on precise calculation, founded on a theory which is generally accepted—though Eddington has recently criticised it (in a paper comprehensible only to a very small group).

It has two consequences—one capable of observational test, the other of considerable general interest.

A mass of gas which had lost all its available heat and settled down into a state of hopeless degeneracy would, *ipso facto*, be dark and invisible at stellar distances. Stars, when dying but not yet dead, would shine faintly and have nearly degenerate cores surrounded by envelopes of something more nearly resembling ordinary matter. We might expect them to be a little bigger—perhaps twice as big as in the final state. Now this is precisely the actual size of the white dwarfs. We should expect, too, to find that such stars were of small mass, and the only two for which we have data have 45 and 93 percent of the sun's mass. This very striking agreement was first pointed out by Milne, on the basis of an approximate theory, and affords excellent reason for believing that these tiny bodies are actually stars in the process of going out. They are losing energy so slowly, in proportion to the brighter stars, that they may linger on for billions of years before they stop shining altogether.

The whole theory, admirable as is its success, applies only to masses of stellar order of magnitude, for which the central pressures are very great. The history of a really small mass—less than a thousandth part of the sun's—would be wholly different. It would never be very hot inside; as it radiated heat away, the more refractory constituents of the gas would liquefy and solidify, and it would end up as a planet—very much like Jupiter, perhaps, in certain stages—and at the end be a cold, solid body with a core of rock surrounding a frozen ocean, and coated outside with a snow mantle of solid hydrogen. The more massive such a body was, the bigger a planet it would make.

This is the opposite of the behaviour for large masses. Hence, somewhere in the interval, the size of a completely cooled body must reach a maximum. Jupiter is certainly on the planetary side, while a body a hundred times as great would undoubtedly settle down as a "black dwarf." The turning point would come at about one one-hundredth part of the sun's mass, and we may guess that the maximum diameter would be not much greater than Jupiter's.

So we have come to the conclusion that *very large planets are impossible*—that is, cold bodies as big as even the smaller stars. Anything as much as half a million miles in diameter—probably even a quarter of a million—must be self-luminous and cannot be in a final state.

The fate of the more massive stars intrigues the imagination. As they cool down they must, so far as we can see, shrink to be far smaller than the earth—smaller than the moon—perhaps no bigger than a large asteroid. By this time something might be expected to happen: but we do not yet know enough about the fundamental laws to work it out clearly. We can hope for no help from observation here; such a body, even while its surface remained hot, would be too faint to be seen at the smallest of stellar distances.—*Princeton University Observatory, May 6, 1935.*

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Largely because of the successful photography of some clouds of unusual extent on Mars, Professor Russell has chosen this and cognate Martian things as the subject of his next article.

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[1]The reader who enjoys skilled handling of differential equations may be referred to the *Monthly Notices* of the Royal Astronomical Society, for January, 1935.

Copper has a wide range of uses. Here is illustrated a mechanically cleaned screen in a sewage disposal plant. It is made of rolled silicon-copper alloy plates—fastened with bolts and nuts of the same alloy

FIGHT CORROSION

Copper . . . Much New Research . . . Many New Uses, Alloys, Adaptations . . . Hardened and Enameled . . . Quick Patina . . . Improves Iron, Steel

By PHILIP H. SMITH

"POUR steel at a temperature of 2600 onto copper which melts at 1950! And not cut, melt or weld the copper?"

"Impossible," some said.

"Let's try it anyway," said others.

So they tried it and it did work. When molten steel was poured into molds supported on copper stools, the high conductivity of the copper dissipated the terrific heat adequately. And with this experiment there was discovered another way to cut steel production costs.

Applied research has been kicking up this sort of stir in copper and copper alloys for several years. Constant pushing against the periphery of the metallurgical unknown has been upsetting tradition and in the metal industry tradition is long, honorable, and well-nigh impregnable. Substitution of copper for cast iron in stools is an example of a successful assault against tradition and logic, but other forms of attack have been made, directed at broadening basic knowledge. The upshot of it is the coming of copper into uses unthought of a few years ago.

Most recent copper developments which have reached the practical stage, make a direct contribution to the consumer. He can now acquire a home built of steel to which a measure of corrosion resistance has been imparted by copper. He can roof this dwelling with copper and have an age-old green patina on it within a very few weeks. Out in the kitchen he can have a range boiler that won't leak and will probably outlast him, while new types of copper tubing and soldered fittings give easier installation of plumbing fixtures. If he owns an old house, copper research has helped him, too. He will soon be able to protect it with a coat of corrosion resistant copper paint, or, if he prefers, he can cover it with copper sheet enameled in transparent colors. Moreover, he can travel much faster to reach this home with less danger of burning out the bearings in his car.

Behind each of these developments is a fascinating story of applied research. Take the copper stools as an example. Here the conductivity of copper is employed to make savings of a dual nature. The ingot as cast is not rough or cracked on its end, with consequent waste, as it is frequently when poured with cast-iron stools, and the copper will last for some 1000 pourings as contrasted to 80 for cast iron. Copper is more expensive at the outset for the metal cost is higher, but when a

copper stool has served out its life the only impairment is cracking or heat checks, and the metal can be recast in stool form for use again.

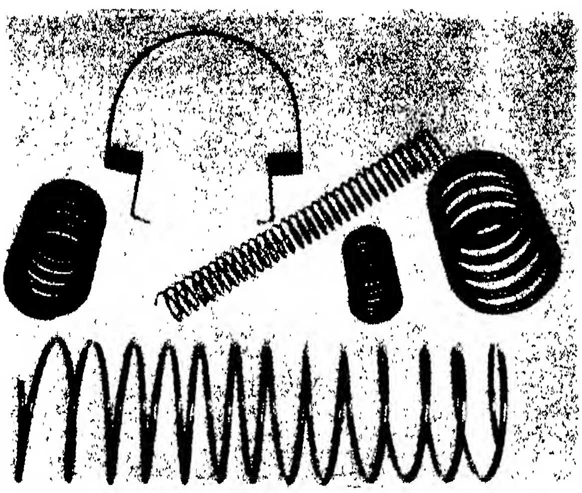
When experimenters had recovered from their surprise that copper could be used for stools—and it was a surprise even to those who banked on its success—the next step was to try copper for molds. Aside from the rapid formation of heat checks, the molds performed well and there is now much to support the contention that the practical use of copper molds is not far away.

ENAMELING on copper had its origin even prior to the Middle Ages. The cloisonné work of the Chinese and Japanese represents an enameling on copper. These older forms hid the metal, produced a thick, brittle, and expensive coat of enamel and were applicable only to objects of art. Not so with the product of modern research. Here the aim has been to preserve the attractive surface and texture of copper, to make the enamel flexible, transparent, and inexpensive. By achieving this goal, enameled copper becomes suitable for exterior and interior wall surfaces, roofs, and decorative building effects.

They call this new process "crystal-cote." It is essentially a special glass melted onto the metal surface. The enamel can be made transparent, merely to protect the copper without concealing the metallic sheen, or it can be in color either transparent or opaque. The trick, of course, was to develop an enamel that would have an expansion and contraction close to that of copper so that it would not crack, and to apply it so thinly that it would have flexibility. This achieved, builders have at their disposal copper in a new form. It is possible to prepare sheets 18 by 48 inches in size in a variety of colors for use where appearance is to be heightened. The sheets can be flexed and cut to shape, and they won't shatter under a moderate blow. Where necessary, nails can be driven through without damage to the enamel and if the enamel should be knocked off there is still a corrosion-resistant surface underneath.

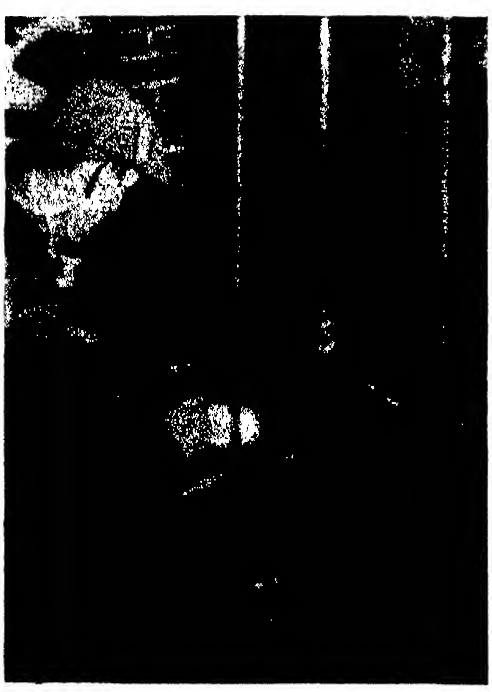
Still good after 60 years of service: an old copper kitchen range boiler

The Statue of Liberty in New York Harbor now features this product of research. The vaulted ceiling of the tunnel leading to the statue is covered with buff-tone "crystal-cote," while the signs which tell the tripper where to go and what to do are made of the same material in two tones, for this process permits the use of colors in combination to produce pleasing effects.



Strength and resistance to fatigue make beryllium-copper particularly suitable for various springs

It wasn't a very big jump in thinking to consider ways and means of simulating the green color which comes over copper roofs on aging, and two ways have been perfected for producing this patina quickly. In both cases the first step was to find out what a natural patina was—what manner of chemical substance was formed by the interplay of the elements with copper. It was found to be mainly a basic sulfate of copper, a composition like that of the natural mineral brochantite. Knowing that keeping a "conditioned" ammonium sulfate solution in contact with copper would produce the basic sulfate, this was tried. But the patina did not form until—and here was a surprise—until after precipitation of a night's dew. So it was discovered that a controlled humidity was needed to produce a permanent effect.



Sweating the fittings together in the newer type of copper alloy residential plumbing

Apart from spraying copper and letting nature take its course, another method has been developed. It comprises applying an electrolyte embodying a certain concentration of sodium bicarbonate and then subjecting it to electrolysis with the copper forming the anode. Now the charming green coloring, which normally requires from five to 12 years by natural process, can be had at will, and quickly.

Other developments bring pipes and fittings into the home in a more advantageous form. Perhaps the consumer has them in his home already but the chances are he does not know it. Such uses of copper involve an improvement in design whereby tubes slide snugly into fittings to be held tightly with solder, and is in contrast to the older form of threaded coupling. This design gives greater flexibility to the tubing and weighs nearly 50 percent less than the old type threaded pipe. Several forms of this new development are on the market; one type is soldered by placing the solder on the edge where the pipe enters the fitting, whence it is drawn into the slide joint by capillary attraction; another, known as the "streamline" fitting, features a perfectly smooth interior wall surface with no shoulders to impede flow. This type is soldered by pouring the solder through a hole in the fitting to fill the slight cavity between the fitting and the pipe. Whatever the type used, heating with a blow torch melts the solder to let the pipe be withdrawn for repairs.

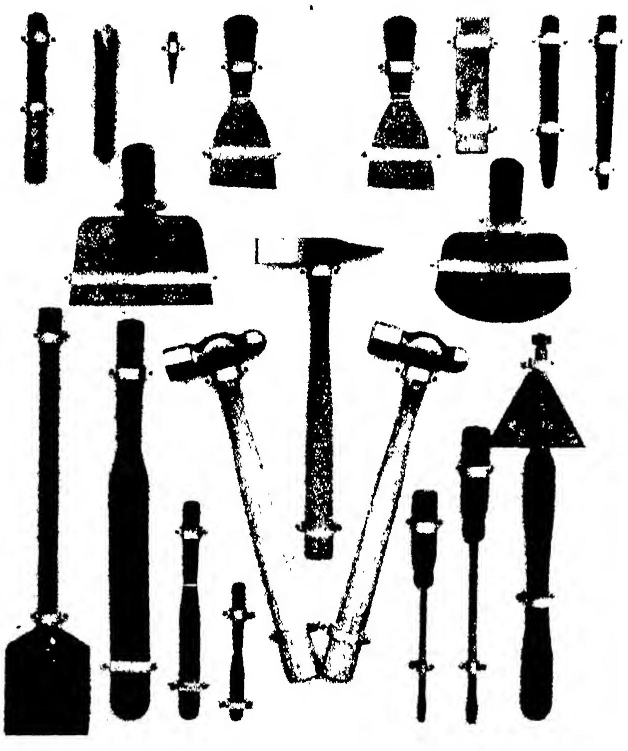
Copper paint, another boon to the householder, is almost too new to mention; it is just on its way from the laboratory. The basic accomplishment, we are told, is the breaking down of the characteristic crystal form of copper to get fine, shapeless particles which will remain in suspension in a suitable vehicle. When applied to a surface, the particles pack together to give solid coverage. Since copper has some affinity for other metals, this paint gives promise of excelling for metal structures, particularly in marine use where corrosion resistance is paramount.

INGENIOUS, but not yet established commercially, is a process for obtaining a relief design or delicately cut tracery on copper sheet. A piece of lace or a pattern in thread is coated in a bath of rubber latex. It is then placed on the copper and sand blasted. The particles of sand bounce off the rubber-covered thread but wear away the exposed copper to create a relief design, or, if blasting is continued long enough, the metal is actually cut out. One can envision great possibilities using the process in conjunction with enameling, for the finished design panel could be protected indefinitely from tarnishing, or given startling color treatment.

If it is resistance to corrosion that has brought copper to the fore for construction work, it is that other quality of high conductivity which has brought it into consideration for automotive use. Starting with the known fact of high thermal conductivity, exhaustive experiments have been carried on to determine whether copper might not be superior for cylinder heads by virtue of lessening formation of hot spots. Under test conditions copper does permit use of higher compression ratios than other standard materials and, of course, this means more power and greater fuel economy. But even without increasing compression, copper cylinder heads have yielded better fuel mileage as compared with aluminum or cast iron and it is thought that there is a definite reduction of hot spots.

Copper cylinder heads have not been adopted commercially, for tests have only recently been completed, but copper-lead alloys have begun to replace the old-type babbitt for main and connecting rod bearings. Like babbitt bearings they will fail in event of inadequate lubrication but instead of promptly burning out and becoming useless, the rate of wear increases sharply and ultimate collapse is delayed. What seems to happen is this: the lead oozes out under excess load and provides enough lubrication to prevent serious injury to the journals.

All these accomplishments of research, novel as they are, are by no means the most significant from the metallurgical standpoint. The laurels must be given for work done with copper alloys, especially the newer ones.



Non-sparking tools made of beryllium-copper. There is no record that the ancients ever made a harder copper

If it were accurate to say that research had rediscovered the lost art of hardening copper to give it the strength of steel, our story of beating the ancients would be blazoned in headlines. Actually the art was never lost, for there is no positive proof that the ancients could harden copper. They produced what seems to be a cold-worked, hard copper, whereas science has produced alloys with steel-like hardness—silicon-copper, beryllium-copper, nickel-aluminum-copper, and others with varying degrees of hardness.

Silicon-copper alloys using manganese as the third alloy are most common; another form uses tin and zinc in combination. The manganese alloy was developed to surmount the high cost of tin. It makes an alloy which has high strength, great resistance to corrosion of the ordinary atmospheric type and also to the action of a large number of chemical corroding agents.

Beryllium-copper, in which 2 to 2.25 percent beryllium and 0.25 to 0.50 percent nickel are added to the copper, makes an alloy which can be given a tensile strength as high as 200,000 pounds per square inch by a "precipitation" heat treatment. Aside from its strength, its outstanding quality is resistance to fatigue. This makes it eminently suitable for springs which have to undergo repeated stresses and vibrations in service. Beryllium-copper enters into the manufacture of small parts where a combination of conductivity, fatigue, and corrosion-resistance is desired, and the making of non-sparking tools for work with explosives or in the presence of explosive gases.

The perfecting of age-hardening copper alloys is of real import to the industrial world. It provides designers with a material combining all the desirable properties found in phosphor-bronze with the added advantage that the alloys can be shaped and formed in a semi-soft state and then heat-treated to impart the strength common to alloy steels. It is a development which has provided industry with a highly reliable, workable, strong, non-corrosive metal of many uses, and with great possibilities for the future.

THOUGH very new, beryllium-copper already has diverse uses. It is stronger than non-ferrous alloys and more easily machined and corrosion-resistant than steel, hence it goes into springs, clips, firing pins, and contact points. Silicon-copper alloy also serves the householder quite widely. The latter is used for range boilers, since it resists corrosion better than ordinary copper, and that means cleaner water. It is nearly twice as strong and ductile as copper alone and it welds easily to eliminate the trouble of leaking rivets.

Copper-bearing steel has been used in farmers' fences for many years, but it is only now coming into its own in the metal-consuming industries. Technically speaking, copper-bearing steel is an iron base alloy and belongs in a discussion of iron and steel technology, but it cannot be overlooked when considering copper and its potentialities.

In the early days of iron and steel manufacture, copper acquired a bad reputation because it was thought harmful to processes and decidedly injurious to physical properties of these metals. Certain iron ore deposits were abandoned for no more reason than that copper was present. Recent research, however, has demonstrated beyond question that small amounts of copper improve iron and steel, aside from the corrosion-resistance quality,

and this illustrates once again what research has been doing in booting aside tradition of long standing.

A slight amount of copper in steel adds quite appreciably to steel life under normal atmospheric conditions. Increasing the copper content a few more fractions of a percent adds greatly to strength. It should not be thought that copper makes steel rustless. It does help but the gain is slight compared with that obtained by addition of chromium. Copper is valuable because it is one of the cheapest alloying elements and because use as an alloy gives increased strength without increasing the carbon content. This makes such steels more suitable for welding structures than higher carbon steels which become brittle after welding.

COPPER-BEARING steels are now in commercial use though their potentialities are hardly appreciated. On a tonnage basis copper doesn't rank high as a metal in alloy steel, but measured in potentialities it is extremely important. It provides a means for building more compact structures and for lightening the weight of transportation equipment—two tremendous volume fields for exploitation. The additional strength means that weight and thickness of structural members can be reduced anywhere from 20 to 35 percent and, coupling the corrosion-resistant quality, will give an equal service life.

Quite naturally, attention has turned to the use of copper in cast and malleable irons, for if adding copper to rolled steel improves its physical characteristics 10 to 15 percent without heat treatment and another 15 to 20 percent after treatment, and if cast steel's strength can be improved as much as 20 percent, why can't the irons be improved in like manner? Research asked the question and has already begun to bring in proof that it was not asked in vain. Cast iron is bettered physically by adding copper. Broadly speaking, its strength and hardness are increased proportionately as the copper content increases, while the effect upon malleable iron is to increase its endurance and reduce its susceptibility to inter-granular embrittlement.

To unearth all of the really significant happenings in copper one must wind up one's digging at the mills where research findings are overhauled to make them practical and economical in the commercial sense. It is there, for example, that bright annealing in controlled atmospheres is carried on successfully. It is there that manufacture of oxygen-free, high conductivity copper has been brought to the stage of utility, not to mention many of the achievements already reviewed.

Oxygen-free copper is more highly resistant to corrosion than ordinary "tough-pitch" copper and it can be welded either with oxy-acetylene or the electric arc process to give a union having the strength of annealed copper. It is now being made in all forms, available for a greater number of industrial uses, though rapid substitution is unlikely because of higher cost. For certain applications it is superior to the tough-pitch variety as, for example, for tubes which must resist gassing attack.

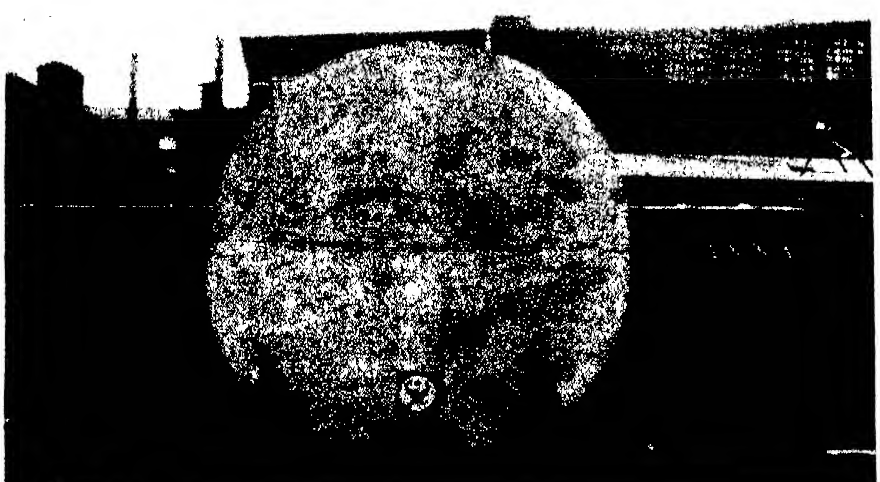
Among achievements in manufacture, two are worthy of special mention as reflecting efforts to cut costs. The first is the electro-deposition of copper in sheet, strip, and foil form, and the second is the swaging of tubing. The former makes possible manufacture of large sheets of uniform thinness without requiring the enormous power which rolling takes. Swaging is likewise a power reducer—a process supplementary to the drawing of tubing. Its purpose is to reduce the raw material in size before drawing starts and it is of real economic advantage when hard alloys are used.

To view all these developments in the copper industry is to be struck with the great volume and scope of basic research that has been carried on all during the depression years. It represents co-operation between producers of the raw materials, the fabricators, and the research organizations to the one end of finding out just what copper has to contribute preeminently to the Power Age. That it has been stimulated by the need to find outlets for copper matters not; the work has been fruitful and of general service. Developments are still coming from the laboratories of the copper companies, from the co-operative Copper & Brass Research Association, and from the Battelle Memorial Institute where much of the recent work has been done, while the labors of the Iron Alloys Committee of The Engineering Foundation continue to bring together all that can be found out about copper as an ingredient of iron and steel.

A cold chisel, tipped with a copper alloy, cuts a cold rolled steel bar

IN the near future we shall probably see commercial development of copper-chromium, copper-manganese, and copper-molybdenum steels and learn much more about the effect of copper on the various forms of iron. Certainly new copper alloys are scheduled to put in an appearance and so are high-strength, copper base, die-casting alloys. Almost any day now we may hear of the successful commercial application of a process of casting thin sheets of copper between slowly revolving rollers.

All this work, completed and projected, provides proof that copper is set to play a much larger rôle in industry. From a new and broader scientific base it challenges other metals. It is no longer the inherent characteristics of corrosion resistance and conductivity alone which recommend it, but these qualities combined with the new ones of strength and hardness, which, all together, provide a formidable combination for the industrial march.



Largest copper-alloy condenser head plates or tube sheets ever constructed

Photographs courtesy The American Brass Company and Stanley Tools.

"Payments on the house amount to no more than rent in the city." Reedsville, West Virginia, homesteaders

BACK ON THE LAND

Subsistence Homesteads . . . Business Arrangement for Wage Worker . . . Home-Grown Food Supply . . . Federal Program Gives Direction to Movement Now Slowly Reversing Urbanization Trend

By JOHN HERRICK
Assistant to the General Manager
Federal Subsistence Homesteads Corporation

JOHN SMITH is an average American worker. He furnishes America with its manufactured goods and its raw materials. He makes something less than 1500 dollars a year when times are good. Out of this income he must provide for himself, a wife, and from two to four children. His chief living cost is for food; his second is for shelter; next comes clothing. When these three essentials have been taken care of, there is very little left. If he has a surplus of 100 dollars at the end of the year, he is lucky.

He is a wage worker. Practically his entire income is the result of his own individual efforts. He lives in a city. He is nearly always a renter. He buys all his foodstuffs at the grocery and market. When he has employment, he and his family can get by. If he is laid off temporarily, he feels the pinch at once. When hard times come and employers cut their payrolls, it is not long before he and his family are in real distress. There are nearly four million John Smiths still on the federal relief rolls today.

Tom Jones is another American worker. His income is exactly that of John Smith; his family is the same size. But Tom Jones is employed in an industry that has moved to a smaller industrial town. He is buying a house and a few acres of land on the edge of town. With his garden, his flock of chickens, his cow, and his three or four pigs, he and his wife and the older children are able to supply themselves with three quarters of the foodstuffs they need during the year. This means a big cut in the chief item of living cost. Payments on the house amount to no more than rent in the city.

BUSINESS falls off. The decline deepens into a depression. Tom Jones can get only part-time employment. His income is halved. But he makes use of the days when he is laid off, to plant a larger garden. His wife cans more vegetables. He feels the lack of cash. It is a tough pull, but he and his family have plenty to eat. They have a roof over their heads—a good sound roof, too. No relief or bread line for Tom Jones. Whether he realizes it or not, he is a subsistence homesteader. He is pioneering on a new economic frontier. He has not gone *back* to the land, but *on* to the land.

For a generation and more, America talked about the back to the land movement. For the most part, it remained a nebulous doctrine espoused by social philosophers who thought in terms of Utopian pastoral societies. In actual practice, the people of the United States were committed to agricultural expansion and urban centralization.

The urban population of the country grew from 28.2 percent in 1880, to 51.4 percent in 1920, to 56.2 percent in 1930. In the decade from 1920 to 1930, the percentage of the total population living in cities with 1,000,000 or more in-

habitants increased from 9.6 to 12.3 percent. It was a busy, prosperous, exciting march of the masses while the good times lasted.

It took the depression to rouse the country to the fact that the process of centralization had passed the point of safety, that an economic set-up in which the great majority of the workers were solely dependent upon pay-roll wages was one perilously liable to being thrown out of balance by any unfavorable economic pressure.

As in the case of all depressions, the past few years have seen thousands of people turn to the refuge of the soil. The back to the land movement is actually being put in practice. But merely *back* to the land is no solution. The random, aimless drift which has taken place so far carries with it dangers of mal-distribution of population and of economic instability as ominous as those of the over-urbanization which brought it about.

And it is here that the federal subsistence homestead program steps in to give direction to the movement already in progress under the inexorable drive of distress. Thousands of John Smiths, urban wage workers, are to be given a chance to go *on* to the land and become Tom Joneses, subsistence homesteaders.

When Congress passed the National Industrial Recovery Act, it included in Section 208, Title II, authority for the President to undertake a program through the establishment of subsistence homesteads which would "provide for aiding the redistribution of the overbalance of population in industrial centers." Section 208 appropriated 25,000,000 dollars to be made available to the President for "making loans for and otherwise aiding in the purchase of subsistence homesteads." The section further provided that "money collected in repayment of the loans should constitute a revolving fund."

President Roosevelt designated the Secretary of the Interior to carry out the program and authorized the creation of the Division of Subsistence Homesteads. The Division was organized August 23, 1933. A subsequent order by Secretary Ickes created the Federal Subsistence Homesteads Corporation to act as the Division's operating agency. To date, more than 60 subsistence homesteads projects are in various stages of development; 40 have been publicly announced and a score or more are in various stages of planning. Among those publicly announced, actual house construction has been started upon some 17 projects, and land development is under way on most of the remainder.

The Division of Subsistence Homesteads operated for its first ten months under the directorship of Dr. M. L. Wilson, who resigned June 30, 1934, to become Assistant Secretary of Agriculture. The work of the Division is now in charge of Charles E. Pynchon, general manager of the Federal Subsistence Homesteads Corporation.

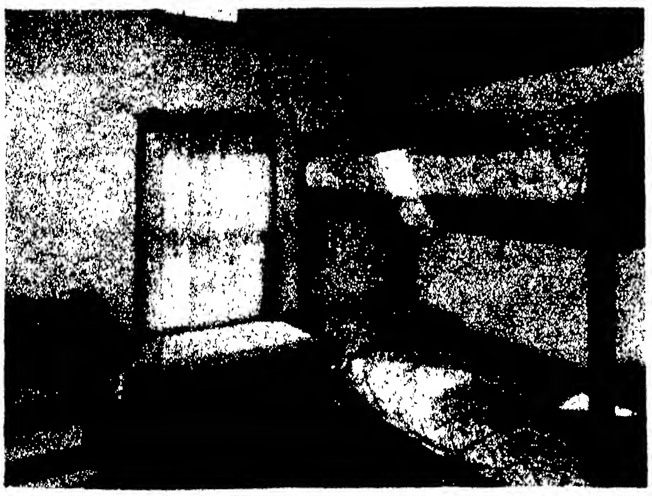
One of the houses now completed and occupied in the Experimental Community at the Reedsville, West Virginia project

The name "subsistence homestead" is self-explanatory. It denotes a house and outbuildings located upon a plot of land on which can be grown a major portion of the foodstuffs required by the homestead family. It denotes production for home consumption and not for commercial sale. In that it provides for subsistence alone, it carries with it the corollary that cash income must be drawn from some outside source. The central motive of the subsistence homestead program, therefore, is to demonstrate the economic and social value of a form of livelihood which combines part-time wage work and part-time gardening or farming to produce a food supply.

The program of the Division of Subsistence Homesteads is being pursued in the sincere belief that it can furnish to large classes of American citizens a means of obtaining greater economic security and a higher standard of living, that its work offers a way to a new economic stability not only of the individual, but of the nation.

The same industrial trend that has broken down economic security has also destroyed certain social values.

Socially, also, the program offers tangible benefits. It gives to those hitherto prevented by lack of capital and income a chance to move from crowded slum and tenement areas, with



Even the furniture of this children's room was made by unemployed under direction of Committee on Self-Help

This living room of one of the homes in the Reedsville, West Virginia, project is plain but neat and comfortable

An attempt is made to uphold the traditions of the locality of each project. Here, under construction, is shown a modified log and stone house in Tennessee

all the social conditions that go with them, to the healthier atmosphere of the suburbs, or the country. It re-emphasizes the home and family as the social unit; it promotes neighborliness and a community life, and in this day of specialization and mechanization, it provides an outlet for individual creative energy.

In addition to its principal aim of encouraging the decentralization of industry, the Division of Subsistence Homesteads is attempting to deal with a number of special problems.

Homesteads projects have been undertaken looking to the rehabilitation of members of the so-called "stranded groups" of industrial workers who have been left unemployed, probably for good, by the moving away or closing down of whole industries, by technological changes, or by the exhaustion of natural resources, as in the case of soft coal miners and workers in the lumber industry.

IN a limited way, and in special areas, the Division is also undertaking demonstrations of rural rehabilitation, in order to prove to urban dwellers that it is both possible and desirable to live on and draw part of their sustenance from the land.

Though the program of the Division exemplifies the new spirit of making the Federal Government the servant and helper of the average citizen, it is neither Federal charity nor paternalism. The Division is not an agency of emergency relief.

The 25,000,000-dollar appropriation as specified by Congress is being used —except for necessary administrative and experimental expenditures—in making loans which the homesteaders will repay. While the risk taken is greater than would be assumed by a private agency, still the whole program is based upon a businesslike arrangement between the homesteader and the federal lending agency. Homesteaders are not given their houses and land, but must buy them under a contract providing, as a rule, for repayment over a period of 20 years. Because of this fact —that it is a business agreement, albeit a liberal one—the subsistence homesteads program carries with it none of the evils seen in loss of self-respect and dependence on a paternalistic government, which often are the results of purely charitable relief.

The responsibility of the Division is to assist families who are on an economic level above that of the sheer relief group. It is essential that homestead families have a reasonably assured income large enough to enable them to meet their payments. It is required also that they be of good character, have some knowledge of agriculture or gardening, and that they be sincerely desirous of co-operating in making the program a success. It has also been ruled that homesteaders must be American citizens.

The attempt is purposely made to choose divergent types of projects so that as many various problems as possible may be dealt with. While projects may be listed as being under development in 23 states, it should be noted that they are not located by states or on any other geographic basis, but are undertaken with a view to covering the various problem areas of the country.

In size, individual homesteads vary from the acre or two of the worker's garden type to from 20 to 30 acres in rural projects. An average homestead would include approximately five acres. Houses range from three to six rooms, and in cost from 1200 dollars to a maximum, in a few instances, of 3000 dollars. The attempt is made to create a homestead which will sell on the average for 3000 dollars or less. This purchase price includes the house and outbuildings, and, in most cases, essential farming and gardening equipment, seed and fertilizer, a small flock of chickens, a pig or two, and possibly a cow, or a horse or mule.

THE members of the Division feel that they are part of a great pioneering movement. The rôle of the Division is that of trail blazer and guide. With the funds at its disposal, generous as the appropriation was, it is impossible for the Division to do more than test out and experiment, and by its success and failure demonstrate what are the safe routes to follow. It must be the task of local government and private enterprise to develop the territory thus opened up. It is the confident hope of the Division of Subsistence Homesteads that the trail it is marking will be broadened by the march of many thousands of John Smiths, on their way to settle the new frontier.

A subsistence homesteader's "castle" at Crossville, Tennessee—and it cost approximately 2000 dollars! This low cost was possible because virtually all raw material used on this project is available nearby. The homesteaders contribute labor, being paid half in cash and half as credit toward purchasing homes of their own

WORLD-WIDE RADIO

All-Wave Reception

A Universal Hobby . . . Daily Weather Reports . . . Noise on Short Waves . . . Care in Tuning

By M. L. MUHLEMAN*

ALL-WAVE reception has become a universal hobby. Every day and hour there are literally thousands of people in all parts of the world occupied in the diversion of tracking down distant stations, or merely enjoying the varied programs, educational features and unexpected thrills the wavebands have to offer. It is the greatest show on earth.

From five meters right up to the edge of the standard broadcast band, the ether is filled with every conceivable type of transmission. In this wide frequency spectrum will be found the commercial radio telegraph stations, the experimental television and radio picture services, the ship-to-shore and transoceanic radio telephone links, the police and aircraft stations, the communication facilities for expeditions to far parts of the earth, the amateur telegraph and radiophone stations and, above all, the large group of international broadcasters.

The international broadcasters operate in the wavelength bands of 11, 13, 16, 19, 25, 31, and 49 meters, the waveband employed depending upon the time of day or night. The police radio stations are to be found at 7 meters (not covered by the average all-wave receiver) and at 120 and 175 meters. The two latter bands are used constantly day and night. The airport stations operate in a number of wavebands, the principal one being in the vicinity of 55 meters. The amateur radiophone bands are located at 5, 10, 20, 75, and 160 meters.

THERE is one more waveband that should not pass unnoticed. It is not a short-wave band, but is incorporated in a few of the latest all-wave receivers. This is the group of wavelengths, above the standard broadcast band, where there are operated some 75 Department of Commerce Weather Report Stations. Complete general forecasts are broadcast six times daily, commencing at 1:31 A.M. and ending at 9:31 P.M. These specific forecasts are for the public and are transmitted on a frequency of 236 kilocycles, which corresponds to a wavelength of about 1271 meters.

Though the high-power stations of Europe, Canada, Central America, and South America lay down strong signals over a considerable area of the United States, it should not be assumed that these stations may be received with the same ease and with the same clarity as a local broadcast station. There are many occasions when these stations are received just as well as a local station, but one cannot hope to expect results of this sort as a regular happening.

OUR Service Department has prepared a list of the Department of Commerce Weather Report Stations mentioned in the accompanying article, which list will be mailed upon request. Stamp, please, for postage. The list gives location, wavelength, and call letters, enabling you to get weather reports from all parts of the country.

Also still available are the Short-Wave Station List, covering the world, and the listing of representative all-wave receivers. They, too, are free on request. Just send a stamp for postage.
—The Editor.

There are many points to be considered with regard to all-wave reception. Most important of these is the change in operating wavelength as the day progresses. Daventry, England, cannot be heard in the 19-meter band after noon, or in the 49-meter band before 3:00 P.M., Eastern Time. Keep in mind that these bands, as two examples, are day and night bands respectively.

The difference in time between countries should also be kept in mind. Thus, Daventry goes on the 49-meter band at 3 o'clock in the afternoon, Eastern Standard Time. But, when it is 3 o'clock in New York it is 8 o'clock in the evening in London.

It would be well to gain some appreciation of the utter uselessness of listening for stations in an unused band, by tuning in on the 20-meter amateur phone band just before dusk, and witness the peculiar phenomenon of sky-wave propagation. For a time the stations in the middle west come booming in at any eastern reception point. As the sun commences to set, these stations slowly fade out and from the background rise the stations in California. These signals hold up for possibly a half hour and then slowly give way to the signals from stations in Oregon, Washington, and Alaska, as the reflected waves of these latter stations pass over the east coast. Finally, these, too, fade out and the 20-meter band becomes as silent as a tomb a daylight band has gone dead for the night.

† WABC

The next point of importance is that of noise. There is considerably more noise in the short-wave bands than in the standard broadcast band. This is accounted for by the fact that such electrical devices as vacuum cleaners, electric heating pads, telephone dialing systems, and so on, create electrical impulses the wavelengths of which fall in the short-wave bands. The radiations from the ignition systems of autos do not spread out quite so much, but raise havoc in the 19-meter broadcast band and the 20-meter amateur phone band. Noises are further accentuated due to the fact that all-wave receivers operate at high degrees of sensitivity when tuned to the weak signals of short-wave broadcast stations, whereas much less sensitivity is required for the proper reception of local broadcast stations.

THESE noises cannot be eliminated entirely, but they can be reduced by the use of special types of aerials designed for this purpose, some of which have been described in past issues of SCIENTIFIC AMERICAN.

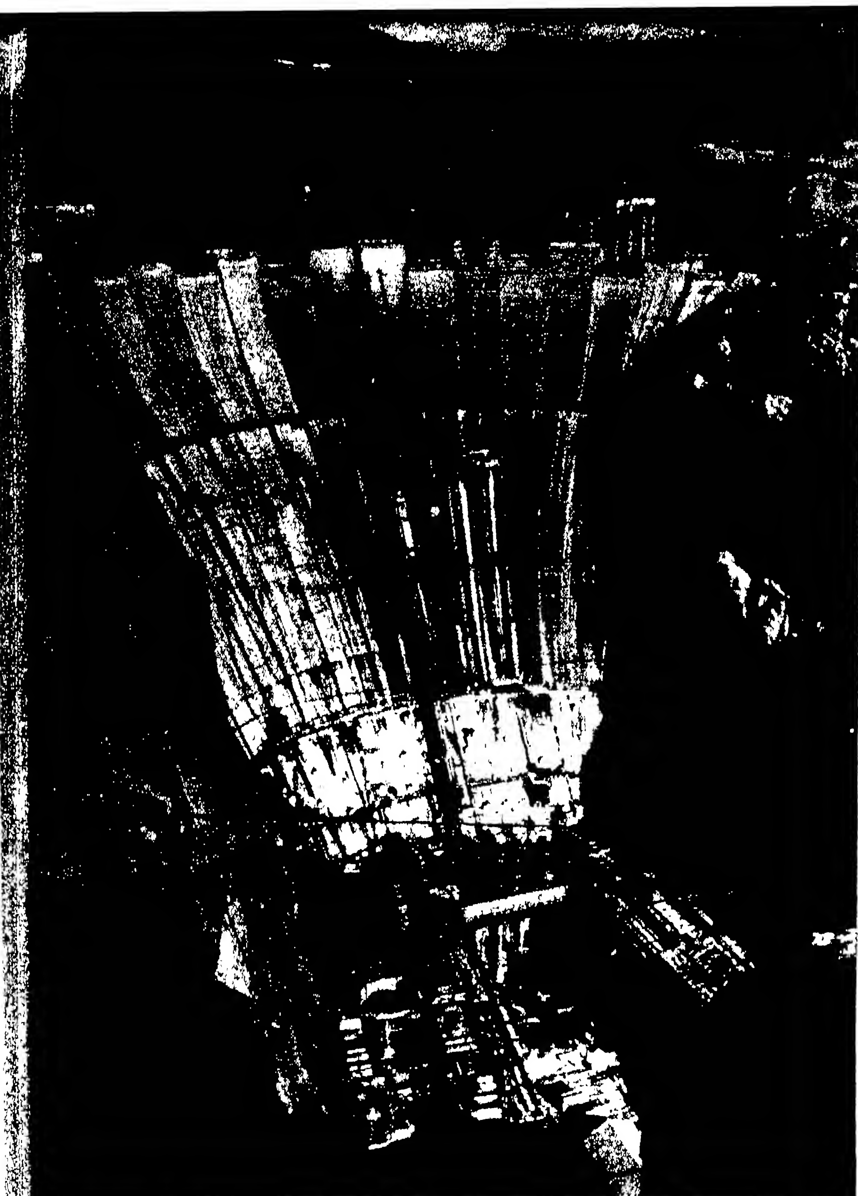
The final point to keep in mind is, that no matter how fine a dial-drive and band-spread mechanism an all-wave receiver may have, one still must tune with care. It is an easy matter to ride right by a station without being aware of its presence. If you choose to track down distant stations for the purpose of obtaining cards providing verification of reception, by all means, tune slowly.

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

†Photograph courtesy Western Electric Co.

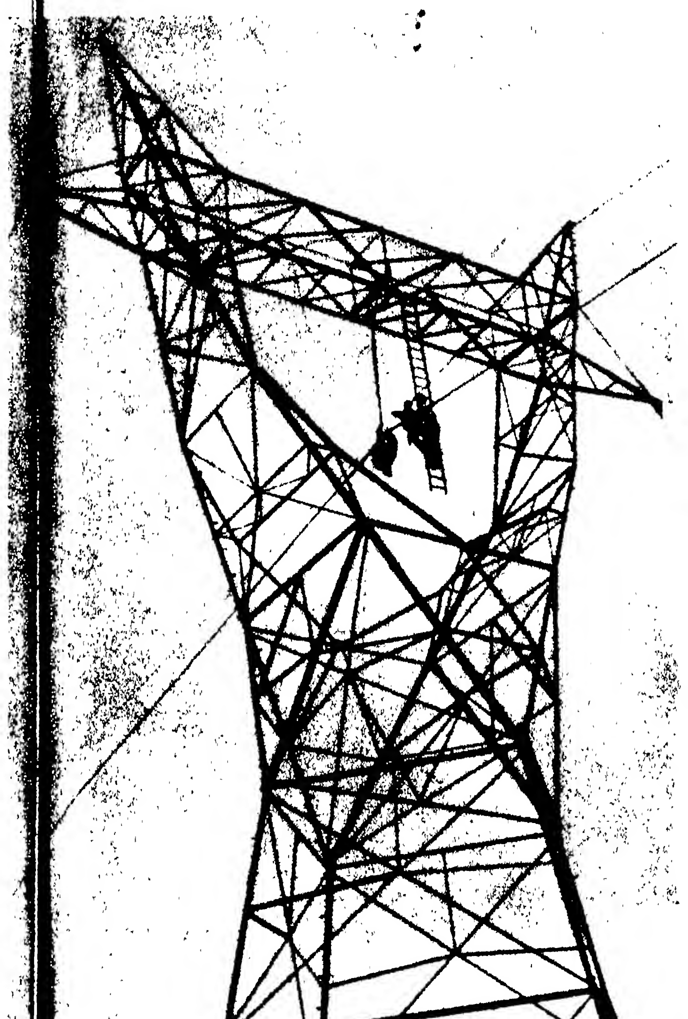
POWER FROM BOULDER DAM

By ANDREW R. BOONE

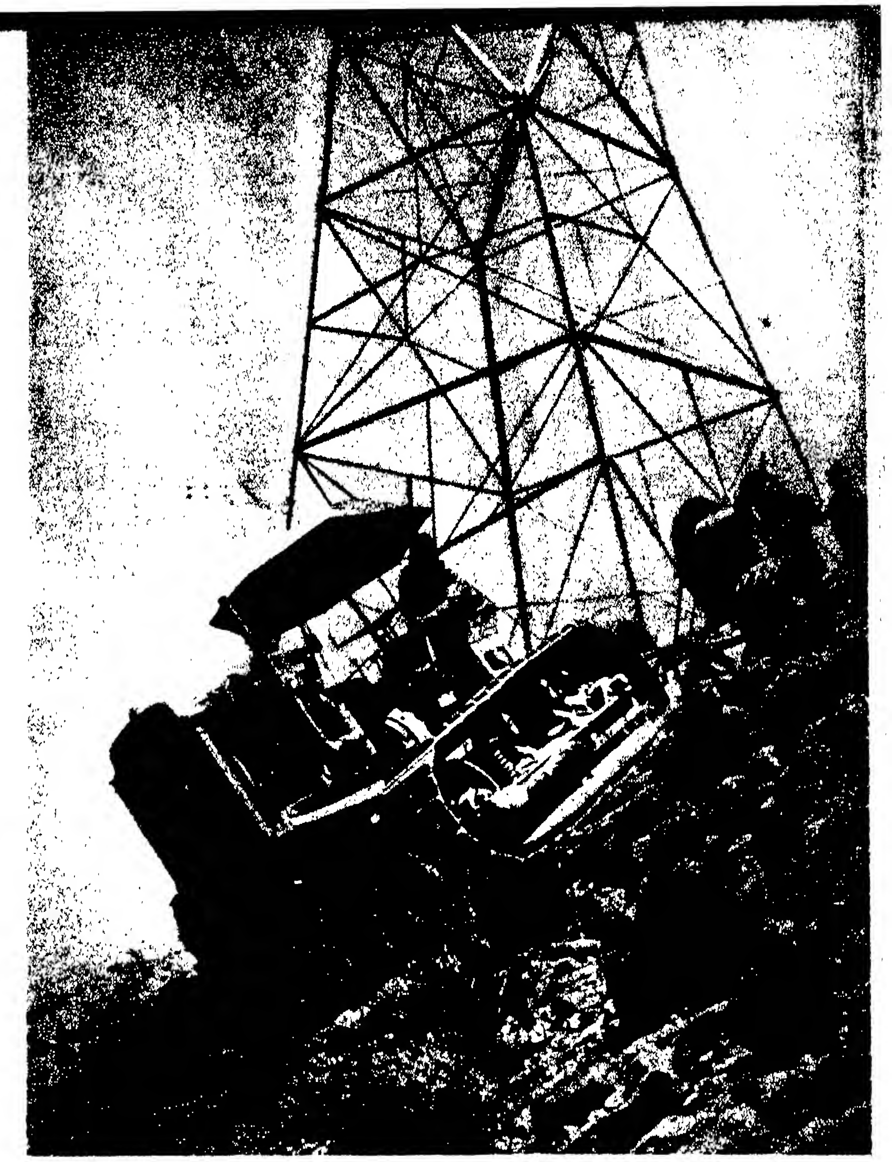


. recent view of Boulder Dam, looking upstream. The water impounded by this ionumental piece of engineering construction will serve a two-fold purpose of irrigaon and hydro-electric power generation, while the dam will act to avert serious flood amage often done by the hitherto unleashed waters of the mighty Colorado River

Equipment used in feeding the transmission line cable, as it is drawn over pulleys on the towers. The cable is pulled from the huge spool in the background, and three turns are taken around the eight-foot drum in the foreground. The operator, in constant telephonic communication with the crew of the tractor hauling the cable, controls the feeding of the heavy copper conductor by means of a hand-operated brake acting on the drum



Left: Perched 90 feet above the ground, linemen are shown at work on one of the pulleys over which the cable is drawn. The Boulder Dam transmission line will carry enough electricity to supply 4,000,000 homes. [See also page 293, December 1934 *Scientific American.* Editor.]

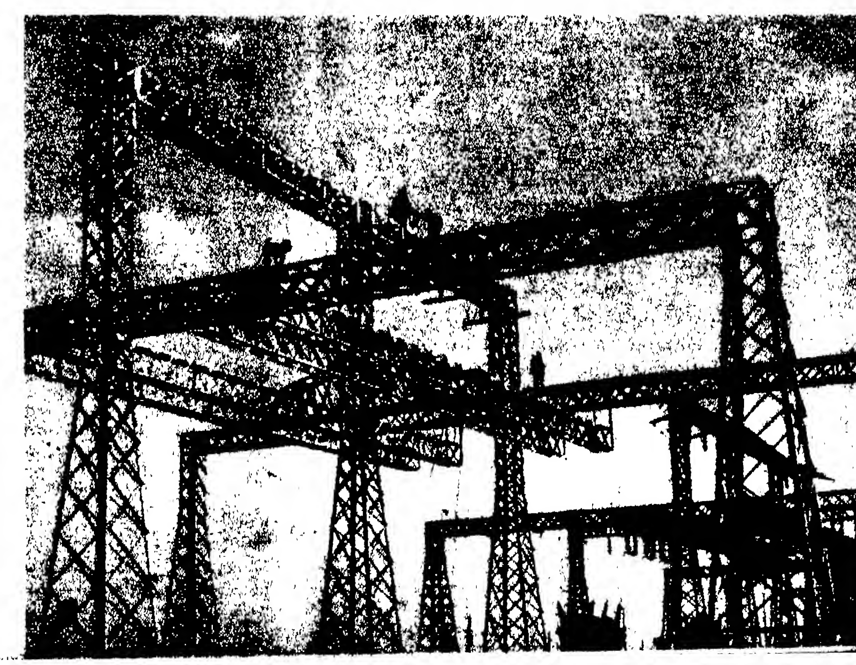


In order to protect the transmission lin and towers against damage by lightning a counterpoise, buried beneath th ground, connects the line of towers. A special counterpoise plow, shown abov operating over rough terrain typical o much of the country traversed by th line, also carries a reel of the cable an lays it in the trench that it has opene

elow: Closing the last of the gates through hich flowed the water of the Colorado River hile Boulder Dam was under construction. Vith the diversion tunnels closed, other work on ie dam and appurtenant projects continues pace, while the enormous reservoir slowly fills

Below, center: A section of the Boulder Dam transmission line, showing the completed double row of steel towers stretching toward Cajon Pass. A total of 2680 of these towers will be erected to support 6727 tons of 1¼-inch hollow copper conductor, measuring 1620 miles in total length, required to transmit electrical energy to the consumers in Los Angeles at 275,000 volts

Below: A huge switch rack to which the transmission line connects, and from whicl power received will be distributed through a network of lines to the ultimate consume



PERSONALITY GLANDS*

Giants . . . Dwarfs . . . Fanatics . . . Neurasthenics . . . Loafers . . . All Made by Disordered Glands

By R. G. HOSKINS, Ph.D., M.D.
Director of Research, Memorial Foundation for Neuro-Endocrine Research, Harvard Medical School

EVERYONE knows in general what personality is, but no one has satisfactorily defined it. It includes everything that gives individuality to the individual. The problem then is, what do the glands contribute to the make-up of the particular self of each of us?

Everyone has many glands—actually living chemical laboratories. Well-known examples are the salivary glands that keep the mouth moist, the tear glands which upon occasion cause salt water to trickle down our cheeks, or the glands in the skin that help keep us cool in summer. These all take from the blood that courses through them different substances which are combined to form secretions. These secretions then pour through ducts to their various spheres of action. The glands which we are to consider, however, are different from those mentioned. Their secretions, instead of being discharged through ducts, are returned directly to the blood stream. Thus they are distributed throughout the body to produce a large number of important effects. These regulatory substances are known as the internal secretions or the hormones.

THE hormones are among the most powerful of all known drug substances. For example, each of us has in his body at any one time about one fifth of a grain of a necessary hormone from the thyroid gland. In the course of a year we use about three and one-half grains of this substance all told. This is a little more than the equivalent of half an aspirin tablet, yet we are all dependent upon this small pinch of material substance, thyroxin, to keep us from becoming complete imbeciles—the statement is literally true. Without thyroid secretion the human being becomes merely a sort of walking vegetable. There are several other hormones equally potent, or even more potent, upon which we are fatally dependent either for existence itself or for the ability to make existence worthwhile. All of these affect personality.

The author

From certain writings of recent years one might get the impression that personality depends upon little else than hormones. Such is emphatically not the case. Many factors go into the determination of individuality.

In the makeup of the personality the two most important features are the mentality and the emotions. The quality of the mind determines whether the individual is intelligent or stupid. Intelligence depends primarily upon the kind of brains one gets from his ancestors, but development of the brain as well as the way it works is to a considerable degree determined by the hormones. Even more important than the intelligence, however, are the emotions. We like one person because he has a jolly, sunny disposition and dislike another because he is glum or conceited. The emotions are closely related to the instincts. Indeed, the emotions might be said actually to represent the way the instincts feel to the person who has them. The instincts are substantially determined by hormones, both in their quality and in their intensity.

We may now consider some of the glands individually. Suspended from the brain in the center of the head is the pituitary gland. When this gland fails to develop properly the individual remains of small stature throughout life. His littleness sets him apart from others of his age and this very fact of being different reacts upon his personality every day. He is always under an inner necessity to try to compensate for his appearance of physical insignificance.

Should the pituitary become over-active during childhood the result is overgrowth. There is now living in a middle western state a boy of 17 who, because of the possession of an over-ambitious pituitary, is over eight feet tall. He can readily tuck his full-sized father under one arm and carry him about the house.

SHOULD over-activity of the pituitary begin after the child is grown up, a different state of affairs arises. No longer is symmetrical development possible, but the excessive growth takes place only in selected parts of the body. He becomes a gorilla-like monstrosity, a so-called "acromegalic." His deformities have of course a constant tendency to warp his personality. But he has more to contend with. During the early stages of the over-growth he is vigorous and virile. If the distortion is not too great he may even turn it to advantage, as once did a celebrated base-ball player who had this disorder. With his enormous hand and powerful muscles he was able to pitch a remarkably deceptive curved ball. He was alert and resourceful. But after awhile the large pituitary gland began to fail, as it commonly does both in giants and in acromegalics.

The case of the base-ball player is rather typical of what occurs in such cases. After a few years he began to slip. He lost his muscular control, became timid and hesitating, and after a very few seasons in second or third rate teams he left base-ball and spent the rest of his futile life as a pool-hall loafer. He was first a brilliant success by virtue of his pituitary secretion, and ultimately a pitiful wreck when he was deprived of this stimulating hormone.

Another hormone from the pituitary determines sexual development. Should this hormone not be secreted in proper amount the individual remains throughout life sexually and emotionally a child. The fanatical reformer is likely to be a person of this type. Having no possibilities in himself of satisfying self-development, he attempts to compensate by making over the world, and thus

gaining a gratifying sense of power.

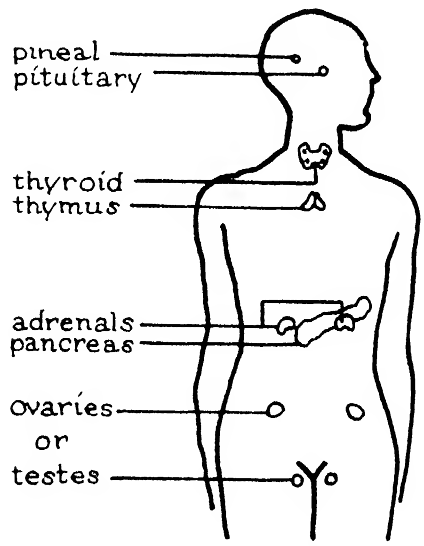
From the pituitary another secretion that regulates milk formation has recently been discovered. During the later stages of pregnancy and after the birth of the infant this hormone aids in keeping up the maternal food supply for the child. It is definitely true in experimental animals, and probably will prove to be true in human beings, that this latter hormone—prolactin it has been called—is an important factor in setting up and maintaining not only milk secretion but the maternal instincts as well. Under its influence unmated female rats have been made to adopt and mother large families of babies, and roosters have been made to cluck. I would not care to say that human mother love is merely a matter of hormone chemistry, but I suspect that the future will show prolactin to have a significant part in this emotion.

In the lower part of the neck lies the thyroid gland. When its secretion is completely lacking the individual lives at only about half the normal vital speed. He is listless, mentally stupid, and sluggish of memory. Aside from a tendency to subdued truculence, his emotional life is almost colorless. Fortunately, thyroid deficiency of this marked grade is rare. Unfortunately, however, lesser degrees of thyroid deficiency are quite common and are frequently overlooked even by excellent physicians. The victims are likely to be over-weight, though this is by no means always the case. They fatigue easily and on slight provocation become cross and irritable. They are able to pull themselves together for brief periods, but soon relapse again into their feeling of inadequacy. Statistics on this subject are not available, but it is altogether probable that a considerable proportion of the unfortunates who go through life labeled "neurasthenic" or "psychoneurotic" are victims of this mishap.

It must be emphasized that there are many causes other than thyroid deficiency for this state of affairs, but in those cases in which it is the cause the condition is readily corrected. Sometimes even as little as one tenth of a grain of thyroid substance a day is sufficient to restore the individual to satisfying normality. Commonly less than one grain a day is needed.

Unfortunate as are the results of thyroid deficiency, even worse is the opposite condition. Over-activity of this gland gives rise to a condition of alert tenseness by which the person may be driven to death. He may live at twice the normal speed. Even with a voracious appetite he is unable to keep the vital furnace adequately stoked, and often literally burns himself out.

The thymus gland in the upper part of the chest has long been under study, but little convincing evidence of its importance has been available until recently. It was believed to have something to do with development, and that when it was defective the individual remained weak and futile in his personality. Within the year, however, it has been reported that thymus extract can produce in the offspring of treated animals a remarkable precocity of development.



Glands which secrete regulatory hormones into the blood stream

When only a few days of age the baby rats were as advanced as they should have been in a month. It is as though human children were ready for high school at the age of three years. The extract has not yet been tried on human beings but the experimental evidence suggests that it may some day prove to be an important resource in the treatment of retarded children.

The adrenal glands which lie just above the kidney also contribute to personality. From these glands is derived the well-known hormone "adrenalin." It is probable that this secretion plays no significant part during times of ordinary quiet existence but that, under emotional stress, it is discharged from the gland and has important stimulating effects that permit us better to muster our bodily resources to meet emergencies. Without the aid of adrenalin we should no doubt be less competent in emergencies and our personalities so much the less effective. In the primitive scheme of existence emergencies called for activity—and adrenalin secretion was probably always helpful. Nowadays, however, emergencies often call, not for immediate activity, but for self-control and calm thinking. Nevertheless, in such conditions the adrenal glands still pour out their stimulating secretions and thus add to the difficulty of remaining calm and collected. It is this behavior of the adrenals which probably gives much of its point to the old saying that "worry is worse than work."

From the adrenal gland is obtained also the hormone "cortin." This substance has only recently become available and its properties are not well known. It seems to influence all of the living cells of the body. When cortin secretion fails, the individual develops Addison's disease, a condition in which the personality suffers. The patient becomes physically weak, restless, irritable, and lacking in co-operation. When cortin is supplied artificially, there results a restored sense of well-being, of energy and of enthusiasm. So much for extreme conditions. What part cortin may play in ordinary everyday life, and especially its influence upon the personality, have not yet been adequately studied. There are on record a few cases in which the adrenal glands have become enlarged and in which the individual, whether male or female, acquired a marked accentuation of masculine attributes. These cases suggest that the adrenals may contribute a quality of virility to the personality, but the quality has not yet been obtained in adrenal extracts.

Finally a few observations may be made about the sex glands. From time immemorial these organs have been removed from farm animals to bring about docility of temperament and to facilitate fattening for market. When the glands are removed before maturity, either in animals or in human beings, the result is essentially the same in all cases. The individuals fail in sexual development. They are more or less lacking in vigor and initiative, though the operation is not actually the ruinous calamity that it is popularly supposed to be. In the experimental animal the mating instincts fail to develop, and in the human subject normal romantic interest in the opposite sex is not acquired as the individual reaches adulthood. When the operation is performed later in life the effects are somewhat variable. A certain degree of instability of temperament is likely to develop and, in women, especially, unusual irritability may be apparent. Individuals of both sexes tend to become over-weight.

The foregoing constitute but a few of the outstanding facts which bear on the subject. The relation of the hormones to personality is one of the most interesting, and perhaps is the most important, topic in the whole field of the internal secretions. Unfortunately, however, the psychological has been the most neglected aspect of the subject. The result is that this important chapter remains yet largely to be written.

Nevertheless we can safely say that the personality is importantly determined by the influence of hormone factors. There are several hormones, the complete lack of any one of which would essentially ruin the personality.

WINGS THAT TURN

Possibilities of Rotating Wing Aircraft . . . Vertical Rising . . . High-Speed . . . Roof-Top Landing

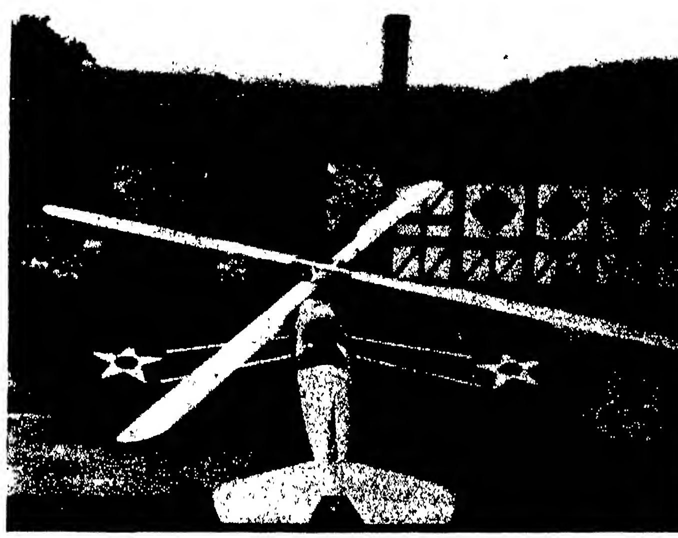
By REGINALD M. CLEVELAND

THERE is every evidence of an awakened interest in rotating wing aircraft. In the effort which is widespread, both here and abroad, to impart certain important safety factors to the flying machine in order to broaden the field of its application and make it more adaptable to the needs of the average man, designers are devoting increased attention to the inherent possibilities of machines with lifting surfaces which revolve around either horizontal or vertical axes.

Thus far, those craft which depend for lift upon vanes rotating about a horizontal axis, such as the Rohrbach plane in Germany and Mr. H. H. Platt's Cyclogiro in America—which may be grouped under the general definition of paddle-wheel aircraft—have not passed beyond the stage of wind tunnel tests. Somewhat extensive tests by the National Advisory Committee for Aeronautics on the last named design, however, indicate that there are no insuperable difficulties, at least in small sizes, and that a paddle wheel machine able to rise vertically, hover, or even to fly backwards, can be constructed.

A prime object of these designs, which might be termed radical, as well as of those aircraft whose rotating vanes revolve around a vertical axis, such as the autogiro, the gyroplane, and the helicopter, is, of course, to assure ascent and descent almost, if not quite, in a vertical path and thus to make usable restricted areas for both landing and takeoff, and to enhance enormously the general utility of the flying machine.

THE helicopter, long considered an aeronautical dream, if not an actual nightmare, gives promise of rapid emergence into a more practical realm. The French are said to have a helicopter which has been able to take aloft a 75-millimeter gun. The British expect to fly this summer a helicopter of the Asboth type built at the Blackburn works, for which test indications predict a flight range of two hours and a reasonable useful load from a power plant of 300 horsepower. This machine is somewhat in the nature of a cross between the true helicopter and the autogiro in that its rotors are of relatively large sweep—39 feet—and, although power driven—which is the essence of the helicopter principle—may be declutched and operated autorotationally as in the autogiro.



A rear view of the latest type of Wilford gyroplane designed for naval use. It is equipped with a fixed low wing and provided with four rotor blades which feather in flight

The same thing holds true of American efforts towards helicopter construction which have not yet reached so advanced a stage. Mr. W. Lawrence Le Page, of the consulting engineering firm of Day and Zimmerman, told the members of the Institute of the Aeronautical Sciences not long ago that he believed a helicopter of relatively small horsepower, having such factors of hybridization with the autogiro, would be entirely practical and give satisfactory performance as to forward speed, useful load, and pay load.

A summary of rotating wing aircraft might also include the convertible airplane called the Herrick vertaplane. This is an airplane designed to take off and fly with the efficiency and speed of the ordinary biplane; then, by release and autorotation of the special upper wing, it can reconnoiter and land with the convenience and safety of a windmill plane. The vertaplane has been in the air both as a biplane and as a windmill plane, although conversion in flight has not, to my knowledge, been accomplished.

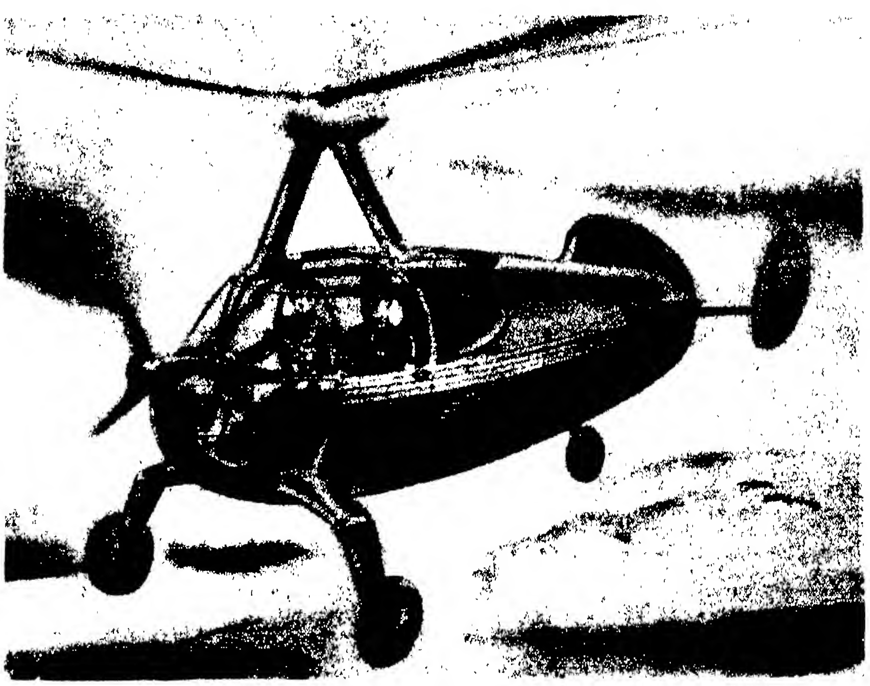
The most notable advances to reach concrete form, however, have been in the field of the autogiro itself. The direct takeoff, or "jump up" described by Juan de la Cierva before the Royal Aeronautical Society, opens up wide new avenues of utility to the windmill plane. [See also page 317, June 1935, SCIENTIFIC AMERICAN. *Ed.*] This takeoff, which is accomplished by spinning the rotor through engine power to a speed above normal while the vanes are at a flat angle, and then declutching and changing the pitch of the blades to a high lift angle, should make possible the use of very small fields or of flat roof tops, and even of landing areas of rough surface such as plowed or stony land—land altogether out of the picture for the fixed-wing airplane.

OF very definite significance for the private flier is the order recently placed by the Bureau of Air Commerce with the Autogiro Company of America for a machine having this direct takeoff characteristic, but, in addition, two other modifications aimed at practical use by the average man. These are, first, folding vanes which already have been applied to the giro, and a method of coupling the engine to the landing wheels so that the machine, with vanes folded, can be driven on the highway and subsequently stored in the ordinary one-car garage.

A number of details, of course, will have to be worked out for the road use of this odd flying machine. Problems of brakes, lights, license plates, and the like naturally will arise. These, how-

ever, are minor considerations which present no real factors of difficulty, and it now seems altogether probable that before Autumn a machine will be in the hands of the Bureau which can not merely descend in a virtually vertical path and land with only a very few feet of roll, but can be taken off again from a lawn or a "pocket-handkerchief" field or, if desired, tuck back its wings and trundle along the roadway to the family garage. Some specifications on this machine are: weight gross 1350 pounds; overall length 24 feet; width, vanes folded, 7 feet; tread 64 inches; wheelbase 114 inches; speed in air (top) 115 miles per hour; on road 20 to 25 miles per hour.

Señor de la Cierva told his British auditors that the direct takeoff, when fully developed, would permit autogiros to jump high enough to clear any number of ordinary obstacles, such as small houses, trees and the like, from a distance of only a few yards. Jumps up to heights of 60 or 100 feet were theoretically possible, he added, without reaching prohibitive accelerations of the rotor before takeoff, but in his view an initial height of about 20 feet would be the maximum required for practical purposes. He pointed out that direct takeoff should offer very interesting and obvious possibilities in regard to seaplane and amphibian application.



An artist's drawing of the "roadable" autogiro being constructed for the Bureau of Air Commerce. This ship is discussed in the accompanying article

THE Spanish inventor had much to say, however, to his audience of British aeronautical experts, about the development of the autogiro aside from this spectacular one of leaping off the ground. He told his hearers that no effort had been made to realize in practice earlier predictions of autogiros of speed and useful load comparable to conventional airplane performances, because attention had been centered on fundamental development of the autogiro principle itself and upon production of the direct control 'giro in which wings and much of the tail surfaces had been dispensed with.

"In many instances," he said, "sacrifices in one direction have had to be made in order to improve some other point until increased knowledge has permitted us to redress the balance again. Simultaneous progress all along the line is only possible when a final formula is established, and the autogiro is only now arriving at that stage. Until then it will necessarily lack that refinement of design which can only be attained by repeated steps in the same direction. Speed, which incidentally we do not consider to be the only criterion of utility of aircraft free from some of the limitations of the airplane, will come as the result of stabilization of general conception and of the concentrated efforts of a greater number of engineers. So will useful load, and while we make no claims to superiority in every respect, we are convinced that we will not be far behind the airplane in what might be called airplane performances."

The inventor cited in support of this opinion statements of John B. Wheatley, an engineer of the N.A.C.A., who has told the Society of Automotive Engineers that "there is apparently ample reason for anticipating the development of an autogiro in the near future that will equal or exceed the high speed performance of the equivalent airplane, that is, an airplane of the same power and useful load."

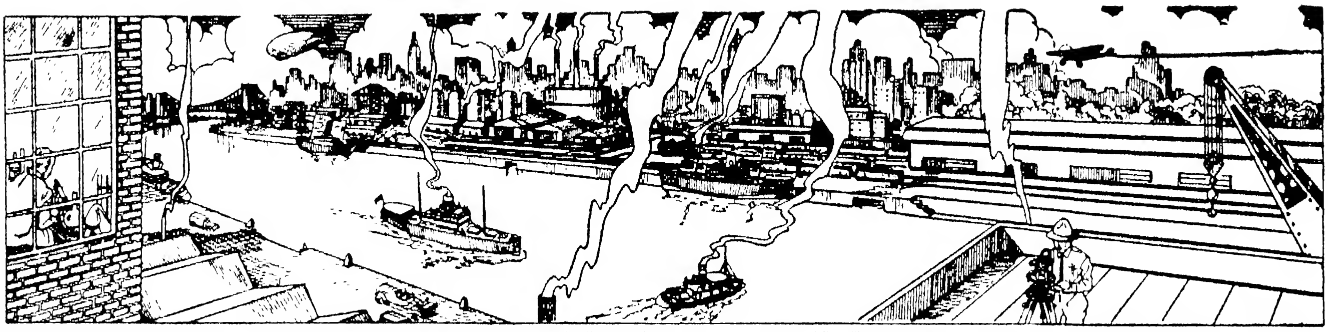
Señor de la Cierva points out that the most efficient rotor produced thus far has a maximum lift-drag ratio excluding the drag of the hub—of between 13 and 14. This represents an increase of some 40 percent on the best rotor of five years ago, and of perhaps 80 percent on early rotors. At the same time, the maximum lift coefficients have been very materially increased.

These results have been obtained by making the blades cantilever and by suppressing the suspension cables, replacing the cumbersome inter-blade bracing by non-reactive dampers at their root attachment, using more efficient airfoil sections, replacing the fabric covering which constituted a relatively irregular and deformable surface, by a rigid superstructure, and by diminishing the solidity considerably.

The reduction in drag-producing solidities has been made possible by a better knowledge of the strength requirements of the blades and refinements in their construction, and by reduction of the number from four to three. Many secondary problems of a dynamical nature were involved in the suppression of one blade, and while difficulties that a further reduction to two blades present are considered of greater magnitude, it is quite possible that this may be done in future. Experimentally, satisfactory two-blade rotors have been produced.

By the introduction of direct control and the elimination of the small fixed wing and even of the rudder for any sort of ordinary flying, the autogiro has attained very greatly improved performances. The most efficient machine thus far built reaches a top speed of nearly 110 miles an hour, and carries a useful load of nearly 500 pounds, with an engine of only 75 horsepower. Absolute maximum speed attained is about 125 miles an hour, and minimum speeds in level flight of the order of 15 miles per hour have been obtained with very lightly loaded machines. Maximum altitude has been around 21,000 feet.

"IMMINENT improvements in various directions," Señor de la Cierva told his British listeners, "will make roof landing a perfectly safe maneuver, and I can say that we are ready to study from now on any form of application involving flying from small platforms or reduced enclosed spaces. The ability of the autogiro has been doubted to reach speeds of the order of 200 miles an hour, without losing considerably on the side of slow speed. This is quite definitely not so. The development of direct takeoff will undoubtedly considerably amplify the field of application and while the autogiro will have many of its own, direct take off and the attainment of high speeds will make it competitive with both airplane and helicopter."



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

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Pneumatic Rivet Passers

RIVETS for both the Golden Gate and the San Francisco-Oakland bridge towers are delivered from the heating forges to the riveters by compressed air. Designed originally for use in shipyards where rivets often must be driven in enclosed spaces walled off from the rivet heaters, the pneumatic rivet passer is new to structural bridge work. Each unit consists of a cone-shaped reservoir placed at the forge, a suitable length of flexible steel tubing and a receiving receptacle in the hands of the bucker-up. The heated rivet is dropped into an opening in the reservoir, and its weight opens a flap valve which closes after it through the action of a counterweight. The operator then releases a blast of air that carries the rivet through the tubing at a speed of about 15 feet per second. The receiver is a metal cylinder containing a spring element that cushions the impact of the rivet.

Above: **Intake end of the pneumatic rivet passer, and,** ***right,*** **the receiving receptacle with spring buffer**

The pneumatic rivet passer is designed for efficient vertical transportation up to 125 feet. The flexible tubing has an inside diameter of two inches, which provides sufficient clearance around the rivet head to prevent the delivery velocity from being too high. Greater safety and lower costs are claimed for this equipment. It delivers rivets to points relatively inaccessible. Heat losses are claimed to be reduced while the scale is removed from the rivets as they slide against the walls of the tubing in transit.—*Engineering News-Record.*

Gun Detector

MANY legends have already grown up around the American "Devil's Island," Alcatraz Prison, in the Bay at San Francisco. One of these has to do with the absolute impossibility of smuggling past the guards guns or tools of any kind. The device which does this mechanical "frisking" may be adjusted to set off an alarm, turn on flood lights, or automatically shut the door leading from the room when some man passes carrying a concealed weapon or metallic tool.

The parallel loops of the gun detector are concealed in the door frame

Recently Dr. David Luck of the RCA-Victor Laboratories gave a working demonstration of this apparatus and a test of it is shown in the accompanying illustration. The system consists mainly of three parallel loops of wire concealed in the framework of the doorway and connected to a control box. A flow of voltage set up in the center, or driver loop, is picked up by the two outside loops, spaced at equal distances apart to create a perfectly balanced circuit. The introduction of a metallic object such as a gun, file, or knife will upset the delicate balance of the circuit, and cause an alarm. The device is absolutely harmless and, unless it is desired, persons passing through will not know they are being examined.

Besides its actual effect, it has a psychological one in discouraging attempts to smuggle weapons into prisons.

Preventing Silver Tarnish

A NEW method of treating silver to render it resistant to tarnish has been patented by a Swiss chemist, Dr. Finckh of Stuttgart. The treatment, which is quite simple and cheap, is said to work equally well with alloys of silver.

The metal to be treated is immersed in a solution containing 0.5 gram of chromium trioxide per liter of water. An alternate procedure is to use a solution of 100 grams

of sodium dichromate per liter of water and to immerse the metal twice, keeping it in the bath for three to six minutes. A third possibility is to use a 10 percent solution of either sodium nitrate or sodium nitrite, followed by immersion in 10 percent aqueous ammonia. Other surfacing solutions may be used, such as 20 to 50 grams of ammonium persulfate, 20 to 30 grams of sodium persulfate, 30 to 50 grams of hydrofluoric acid, or 10 to 30 grams of copper sulfate (slightly ammoniacal) dissolved in each case in a liter of water. The more concentrated the solution used, the shorter must be the period of contact with the metal.

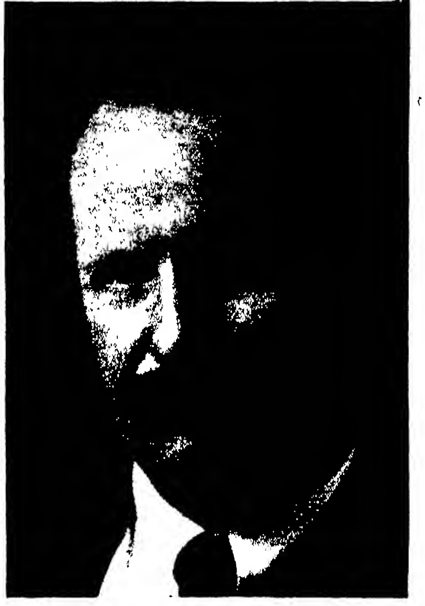
In the case of pure silver, a solution of 10 grams of sodium sulfide per liter of water is recommended. Naturally, this forms a coating of silver sulfide over the entire surface. The object is then immersed in a dilute sodium cyanide solution. Here, as in all other cases mentioned above, a protective coating is formed, but its thickness is kept so slight that the original natural color of the metal is maintained. —*A. E. B.*

PROGRESS In This Age Of Science

As Told to SCIENTIFIC AMERICAN

By KERMIT ROOSEVELT

President, Roosevelt Steamship Company, Inc.



THOSE of us who spent our days of childhood in the 1890's have seen many and miraculous changes in this world. Even the elastic imagination of a child would have to be stretched beyond all bounds, if asked to vision in the guise of anything but fairy tales many inventions which we now regard as commonplace, such as the radio and television and the transatlantic telephone. Indeed it was not until my father was President that we had either electric light or telephone service in the house at Oyster Bay.

Transportation has also gone through its own amazing transformation. The automobile made its entry, causing a complete revolution in the building of great trans-continental highways, with the result that the railroad has been challenged by private motor cars and buses and trucks.

Those of us who make our livelihood from ship operation are very naturally keenly interested in watching the development of commercial aviation. The steamship can scarcely be wholly superseded, but unquestionably both passenger and freight traffic by air are assuming increasingly important rôles. Every year new lines are opened up, and for those who are adventurous or in a hurry, the difference between crossing from San Francisco to Honolulu in 17 hours instead of four days makes a very definite appeal.

In no business can one afford to stand still, and in nothing is this more evident than in the world of transportation where, if we are to survive, we must keep alert to every development and improvement.

AUTOMATIC BROADCASTS OF FLOOD WARNINGS

THE State of California is now operating a series of automatic radio stream gage transmitters in connection with flood control and watermaster service activities of the Division of Water Resources.

The use of these radio stream gage indicators serves the public interests in California in a very vital respect. During major flood conditions advance information on the rapid fluctuations of streams on which

Courtesy *California Highways and Public Works*

The mechanism that sends out automatic flood warnings; and inventor

they are installed make them of paramount importance in the saving of life and property. In the watermaster activities the saving of water and crops and the protection of individual water rights are of major importance.

The radio transmitters, entirely automatic in operation, at frequent intervals send out a signal indicating the gage height of the stream at the moment. The signal is received in the State Engineer's office in Sacramento.

The fluctuations of stream flow in the major rivers contributing to the potential flood hazards in the valleys can be observed directly and accurately many hours in advance of the time when the crests of the high water would reach critical points on the valley floor. By means of this advance information a better, safer, and more satisfactory operation of the various flood control and relief structures along the river can be accomplished.

These automatic radio stream gage indicators are made possible by the use of a unique automatic keying device which was originally developed privately in 1931 by Associate Hydraulic Engineer Irvin M. Ingerson, shown in the photo at the left.

The flood warning device is in the little shelter atop the gage well

The automatic keying device consists of a series of commutators that are so arranged as to "key" the radio transmitter to give a signal that is the accurate gage height of the stage of the water at the time of transmission. For instance, a gage height of 7.42 feet would be listened to as being seven short dashes, at one-second intervals (easy to count), then a pause, then four dashes, then a pause, and then two dashes. The call letters of the station are also automatically "keyed." The keying device is operated by a weight-driven clock and by a float on the water surface in the gage well.

FAMOUS COD LOSES SUPREMACY

COD-LIVER oil, old-time standard rickets remedy, has not nearly so much rickets-preventing vitamin D or growth promoting vitamin A as many other fish oils. Oils from mackerel, tuna, sea-bass, and swordfish have from 100 to 400 times more of these vitamins than cod-liver oil, Dr. Charles E. Bills of Mead Johnson and Company reported at the last meeting of the American Society of Biological Chemists.

Three-quarters of all the liver oils were more potent than cod-liver oil in vitamin D and nearly all surpassed it in vitamin A. The vitamin content of the oils varies with the zoological classification of the fish. Most potent in vitamins A and D are the fish of the order *percomorphi*, to which belong mackerel, tuna, sea-bass, and swordfish.

Next come rockfishes and sculpins. Fish with soft bones contain little vitamin D and no measurable amount of this vitamin could be found in sturgeon or gray sole.—*Science Service.*

AIR PASSENGERS

CIVIL airplanes in the United States carried 1,859,031 passengers in 1934. In 1933 the total was 1,739,275. Of the 1934 total, 461,743 made flights on domestic scheduled air lines.

"Our Wings Grow Faster"

ONE of the most experienced and well known American airplane designers. Grover Loening served in the early days of aviation as Chief Engineer for the Wright brothers and pioneered with the famous Loening amphibians. While not immediately active in the construction of aircraft to-day, he is maintaining his interest in aviation to the fullest extent, and his recent book "Our Wings Grow Faster" has created somewhat of a sensation. The book is partly autobiographical, partly historical. In Mr. Loening's case biography and aviation history are really one and the same thing. Charmingly and vividly written, it is astoundingly frank. The history of American aviation is one of great achievements, both engineering and industrial, coupled with some incidents which are not entirely to its credit. The not so creditable side of this industry appears here for the first time between the covers of a book.

Thus in a section headed "The Detroit Conspiracy," he writes: "Preparedness parades were taking place all over America in the latter half of 1915 and 1916. And 'patriots' were already arriving in Washington in the soon-to-be-familiar guise of 'dollar-a-year men.' Some of these were perfectly sincere, with high motives. But the way step after step led the automobile crowd in Detroit to the ownership, control, direction, and parceling out of practically all aircraft and aircraft-motor business, by the time we entered the war in 1917, is a pattern that fits much too beautifully together to be accidental."

Under a heading "The More Cost, the More Plus" he makes the following bitter but well informed indictment of our airplane manufacturing policy during the war: "Just stop for a moment to consider that our aviation plants of the period just before our entry into the war could, with reasonable enlargement, have easily delivered to the front by November, 1918, over 2000 two-seater airplanes equivalent in performance to D.H.'s and much safer. And yet the Detroit cabal's great effort had produced only 213 planes in Europe by that time. . . . Delivered 213 airplanes at a cost of 640,000,000 dollars! Not quite true, but it is not so far off either."

But it must not be thought that the author is concerned with solely "de-bunking." His book deals with the most striking and important events and greatest advances of American aeronautics, in a vivid, concise, and absolutely fascinating manner.

Grover Loening secured, on his thesis at Columbia, the very first degree in aeronautics, Master of Arts. His thesis was first published in a series of articles in SCIENTIFIC AMERICAN in 1911, and then reprinted in one of the very earliest technical works in this field, "Monoplanes and Biplanes."

In "Our Wings Grow Faster," the author tells how he chiseled his first flight; of early days at the Wright factory; the first successful flying boat; the early history of the Army's aircraft division; America's great come-back in aviation after the war; the inception of the Loening amphibian; the boom times as they affected aviation; sidelights on Lindbergh; the great deflation of aviation securities—each brief section is as fascinating as the other.

Grover Loening, plane designer and author of "Our Wings Grow Faster"

Loening is an individualist and his own efforts were successful because they were individual. Why did he succeed as a designer? "I could have merely taken orders from perhaps a regimented, government-dominated board," he writes, "decreeing the design of the next larger or faster D.H. 48 which would undoubtedly have been a washout for two very good reasons. First, a board is long, narrow, and wooden. Second, you cannot create or inspire talent by order of the commanding officer." It is fortunate for aviation that the well beloved and brilliant Grover did follow his own bent.

What of the future? "So we shall see faster, and still faster commercial flying. At five hundred miles an hour, 50,000 feet above the ocean, flying through the warmer stratosphere, far above storms or ice or fog, sealed in a cabin furnished with conditioned air at ordinary sea-level pressure this is the way we will cross New York to London in six hours in the not very distant future."

Altogether a stimulating and inspiring book.—*A. K.*

British Air Subsidy

IN a recent article by Mr. Igor Sikorsky which we published, a statement was made regarding the subsidy to Imperial Airways by the British government. In justice to the airline, we publish below an abstract of a letter from the Air Ministry in London which gives in detail the facts concerning the subsidy:

"In reference to your letter to the British Air Ministry . . . in . . . 1924 Imperial Airways was formed with a nominal capital, subscribed by the public, of £1,000,000 and in an agreement with the British Government this Company received a subsidy of £1,000,000 spread over 10 years. This sum worked out at £137,000 for the first four years, after which there was a sliding decrease until the end of the tenth year at which time the Company was to receive a final payment of £32,000."

EMERGENCY

THE 272 Department of Commerce emergency landing fields in the United States are now open for casual use by licensed aircraft as well as for emergency use by any aircraft, provided the pilots comply with regulations pertaining to the use of such fields.

The Future of the Airship

NOW that the depressing effects of the *Macon* disaster have worn off, we can discuss the future of airships dispassionately.

The first reaction of the public and press was that the wreck of the *Macon* marked the end of the American airship history, because of the extreme hazards involved in their operation.

But, strange as it may seem, a better theoretical case can be made for airship safety than for airplane safety. They have inherent stability under the action of gravity, can hover without using up fuel, their motors can be repaired in flight, and they have so large a range that fog and loss of course are no longer to be feared in transoceanic operation. The specifications for airship strength carry theoretically a larger margin of safety than do airplanes. An airship cannot indulge in aerial acrobatics, but neither is it subject to stalls and spins.

This all seems at variance with the record of destruction. But if this record is examined more closely it will be found that failures were due to political and service considerations, and to lack of continuity in training of the naval personnel. In the wreck of the *Shenandoah,* the Commanding Officer disregarded the advice of his Aerological Officer to go south. On board the *Akron,* the Commander acted with pitiful confusion in trying to avoid the violent storm areas. In the *Macon* disaster, the testimony indicates that the weakness of the fin was disregarded because the airship had to take part in naval maneuvers.

The Goodyear Zeppelin Company has operated its small blimps for six years, and carried thousands of passengers without accident. The splendid record of the *Graf Zeppelin* in world flight and many transatlantic crossings is familiar to all of us.

If naval officers were not switched from airships to battleships, and if the airship were used with more discretion, it would be no more hazardous than the airplane.

Commercial operation of the airship across the Atlantic has been shown again and again to be practicable and profitable, at least in the most serious engineering studies. At the moment there is no seaplane which is really capable of use across the Atlantic in regular passenger service. This summer the Zeppelin company plans to put its new airship into regular service across the Atlantic, and this will be a most interesting experiment.

The threat to the commercial use of the airship is that its place may fall between the fast liners such as the *Queen Mary*, with a service of a little over four days across the Atlantic and luxurious accommodations and general holiday atmosphere, and the airplane capable of non-stop operation between New York and Paris at a cruising speed of 200 miles per hour. Such an airplane, Mr. Igor Sikorsky tells us, is entirely feasible with present day knowledge of aerodynamics and structures.

What would be a reasonable national policy with regard to airships? Let us use the privilege of a mere writer to lay down the lines of such a policy, for Washington perhaps to read and certainly to disregard!

Let us continue to build naval airships, but build stronger rather than bigger craft, sacrificing some of the extreme requirements of the Navy and putting more of the structural weight into structural strength. Also let us not concentrate too much on one type, the neo-Zeppelin type, but give the Metalclad principle a chance, and perhaps look into the semi-rigids which have done such wonderful work.

Let us organize the airship service of the Navy into a distinct unit so that our splendid officers and men may receive better training, particularly as regards weather and storm avoidance.

It would be advisable also to keep a careful watch on the new German service across the Atlantic, and if this proves satisfactory, to appropriate money to finance such service under the American flag.

But since the seaplane is so strong a potential rival of the airship even in over-ocean service, any step in financing airships for commercial service should be balanced at a quarter the cost by giving the heavier-than-air constructors a chance to see what they could do in giving us an airplane or flying boat capable of real speed and non-stop operation across the Atlantic.

We have tried to make this brief statement as impartial as possible. Airship people reading it will be only partially satisfied. The airplane people are immune to criticism; exponents of lighter-than-air are particularly sensitive to even the mildest expression of doubt or criticism. —*A. K.*

A Cargo Carrier

WHILE a great deal of air express is being carried through the air, our airline operators have so far been content with using airplanes designed for the triple duty of carrying passengers, mail, and cargo. It has remained for the Army Air Service to purchase perhaps the first all-cargo transport in America. This is the Fairchild cargo transport, termed by the Army *XC-31*. It is not in the 200-mile-per-hour class, but has, nevertheless, a top speed of a little better than 160 miles per hour, an empty weight of 7322 pounds, and a useful load of 5678 pounds. The ratio of useful to gross weight thus is about 41 percent. This is a very high figure for a modern land transport. The payload is 3600 pounds, which is also far more than is usually carried in a modern transport of this size.

The Fairchild *XC-31*, an all-cargo transport purchased by the Army

The machine is, indeed, a flying freight car. All the luxuries of modern air transport have been dispensed with. The cabin, with small windows, has a cargo space 19 feet long, 6 feet 4 inches wide, and 6 feet 4 inches high, with a capacity of 775 cubic feet. When the ship is at rest on the ground the cargo door is just at the right height to register with the tailboard of a standard Army truck backed up alongside.

The Army drew on all its operating experience in drawing up the specifications of this machine. Spare engines, whether air or liquid cooled, can be put inside the cabin in regular packing boxes. Three Wright Cyclones constitute a capacity load by weight. All kinds of materials can be lashed to demountable stanchions or to the floors. For the transportation of wounded, six litters may be installed, three on a side, leaving plenty of aisle space for attendants to work in, or for additional wounded to be carried on chairs. As a troop carrier, 15 Army chairs may be installed and military equipment can be lashed down between the chair aisles. For delivery of emergency food or supplies, a large cargo chute has been installed, from which containers may be ejected and guided by parachutes to the ground. The single pilot's seat is in an enclosed cabin, high up, from which the range of vision is adequate in all directions.

The plane is built mainly of dural with fabric covering. Wheels are retractible and a Wright Cyclone is employed for the power plant.

We have often had occasion to speak of the Zap flap. This forms a part of the lower surface of the wing and not only hinges downwards but moves backwards. As a result, its lift increasing qualities are far greater than those of the ordinary trailing edge or split flap. This flap is clearly shown in its retracted position in the photograph. —*A. K.*

Passenger Comfort

IN a paper presented before the Institute of Aeronautical Sciences, Preston R. Bassett defined, for the first time in the literature of aviation, what constitutes passenger comfort and discomfort in air travel. His findings are based on careful and practical studies conducted over a period of years, with flying experience on many types of aircraft both in the United States and in Europe. The accompanying chart gives a graphic illustration of his views on the subject of comfort.

In this chart there is an interior Comfort Zone, within which the air traveler is entirely comfortable. To this Comfort Zone there is a psychological boundary, outside of which is the Discomfort Zone. The boundary is termed a psychological one, since the discomfort just outside of this boundary is largely in the mind of the passenger. At the outer limit of the Discomfort Zone, there is another boundary which is termed the physiological boundary, because at this point the discomfort is truly physical, and because outside this boundary the human body cannot function continuously.

Skilled pilots of experience can "take it" much better than passengers. They are scarcely affected in the Discomfort Zone, and can even stand up to some degree of the Unbearable Zone which lies outside the physiological boundary. But it is not the comfort of the pilot with which airline operators are primarily concerned. In fact, a pilot very "resistant" to discomfort may be an actual drawback to the popularity of the airline, while a sensitive pilot with less hardened reactions is apt to be more mindful of the happiness of his passengers. For example, at the discussion of Mr. Bassett's

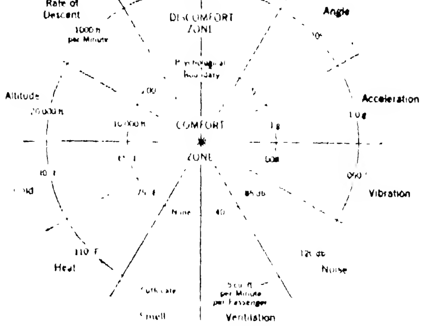


Chart of air passenger comfort

paper, one veteran pilot, Haizlipp, pointed out that he kept his passengers from airsickness because his sense of smell was so acute. He smelled exhaust gas fumes long before anyone else, and made sure therefore that the air inside the fuselage was always sweet and clean.

The great value of Mr. Bassett's work lies in the fact that he has measured and assigned definite quantitative values to the

various factors of comfort and discomfort involved, and these are given in the chart. All these factors interact and produce airsickness, which is of the same physiological character as sea sickness, or train sickness for that matter, with the same unpleasant symptoms. The Passenger Comfort Chart will repay close study.

The first section of this chart is termed "Angle." When a ship at sea or an aircraft rolls five degrees or less, the passengers remain comfortable. Beyond 5 degrees, the actual physical discomfort increases rapidly, and at 20 degrees roll everyone is uncomfortable (including the captain or the pilot) and all those who are going to be seasick or airsick are already in that condition!

The second section deals with acceleration. To most people sudden up or down motion is much more unpleasant than pitching or rolling, and air travelers speak with particular distaste of "bumps" or "air pockets." It is only necessary to have an acceleration 1/10 that of gravity to pass into the discomfort zone, and 1 g. is unbearable. (In an elevator the maximum acceleration is probably only 1/3 g.)

The next sector on the chart is vibration. Mr. Bassett has measured vibrations with the "vibrometer" and finds that vibrations of more than .008 of an inch cause a passenger to keep his muscles tense and prevent him from relaxing. Hence the great emphasis laid in airplane design in preventing engine vibrations from reaching the passenger cabin. It is not difficult to cushion the seats so that very little vibration reaches the passenger through the seat, but it is equally important to prevent vibration of chair arms, floor, foot or head rests, and so on.

When it comes to ventilation, it has been found that more rapid change of air is required in the airplane than anywhere else, and a minimum of 40 cubic feet per minute is necessary. This is far more than is provided in the best of the modern moving picture houses.

We have often discussed noise in the airplane. A decibel level of about 70 is found in a Pullman car, and anything up to 85 is within the comfort zone. A level of 120 is unbearable.

Mr. Bassett has done a splendid piece of work in setting up specifications for comfort. Our airplane designers and constructors now have something perfectly definite to try for, and they are rapidly conquering the problems involved, with much help from the Sperry company, whose automatic pilot has largely removed pitch and roll, and whose sound-proofing studies have done so much to silence the airplane.

MILES PER ACCIDENT

MISCELLANEOUS aircraft operators in the United States flew 392,141 miles per fatal accident in the period July-December, 1934, representing an advance over the corresponding period of 1933 when the miles flown per fatal accident were 377,200.

A Fine Engine for the Private Plane

THE Fairchild Aviation Corporation announces that its subsidiary, the Ranger Engine Corporation, has actively entered the aviation market with a series of 6-, 8-, and 12-cylinder engines, as the result of four years intensive engineering work. Without slighting the other fine motors being produced, we describe below the 6-cylinder engine, which is particularly well adapted for use in private planes, and which like the others of the series is in-line and inverted.

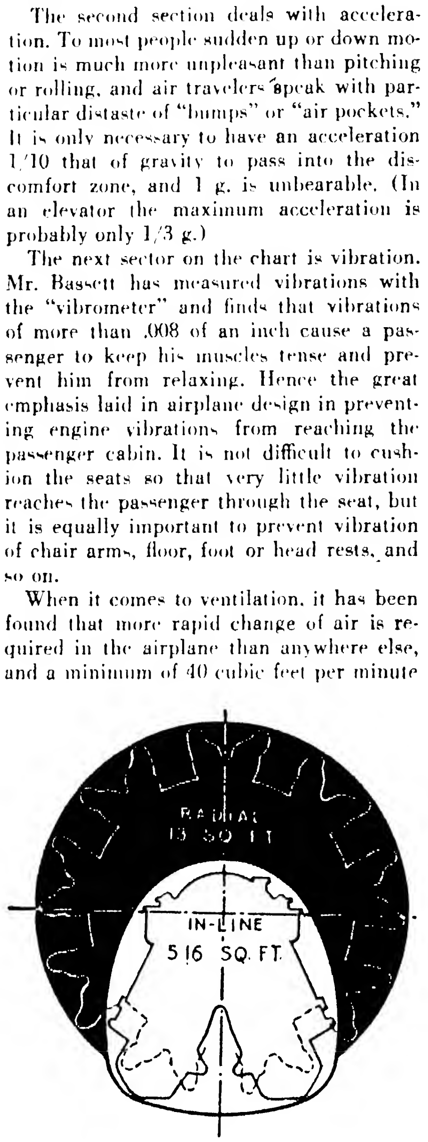
There is a definite reason for the utility of in-line inverted engines. As the diagram indicates, the in-line engine of power equal to the radial has a very much smaller frontal area. With the large radial, no air resistance can be saved in a military ship by cutting down the cross-section of the fuselage, since the large frontal area of the radial is still there to disturb an equal area of air. With the in-line, the fuselage can on occasion be cut down, with appropriate aerodynamic saving. In the private plane, the dimensions of the cabin cannot very well be reduced to match the engine, but the smaller projected area of the engine, particularly when it is inverted, gives the pilot improved vision over the nose of the plane. And improved vision is one of the vital elements in airplane design. Also an in-line engine lends itself nicely to streamlining.

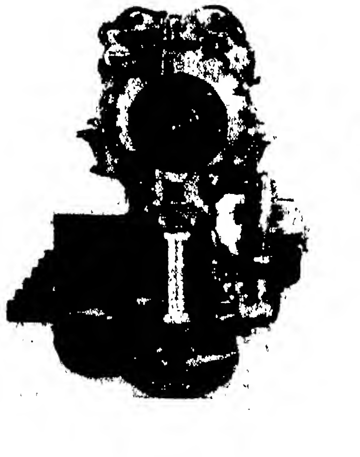
The 6-cylinder Ranger develops 145 horsepower at 2250 revolutions per minute and has a dry weight of only 350 pounds. It has stood up successfully to power tests at speeds much higher than this rating, namely 3500 revolutions per minute, and has developed a mean effective pressure of 230 pounds per square inch. This gave 69 horsepower per cylinder and 1.04 horsepower per cubic inch displacement. Those of our readers who are familiar with automobile engines, will by comparison recognize what an immense concentration of power this means. The engine is cooled by placing a scoop at the side and leading air to each cylinder by means of baffles.

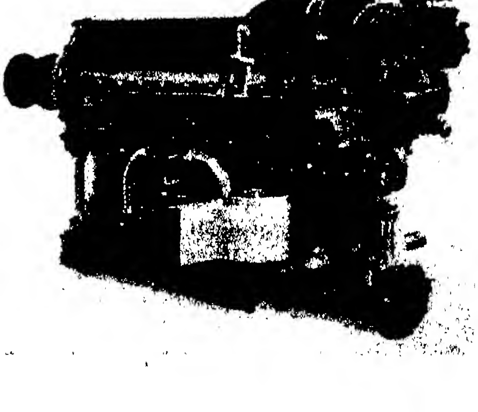
With its six cylinders and perfect balance, the Ranger is smooth running and almost entirely free from vibration. Here are a few other points which should appeal to the experienced operator:

There are no parts to be oiled manually, with the exception of the magnetos, as all moving parts are lubricated by full pressure feed from the engine-driven pumps. The valve actuating mechanism, due to the inverted design, is completely enclosed in an aluminum housing, the cover of which serves as an engine oil sump. Failure of the oil system is forestalled by a special feed system The pressure feed to the main bearings and the connecting rod bearings is so designed that each bearing is fed with oil from both sides.

The in-line principle in engine design, skilfully embodied, is bound to be of great service to private flying. *A. K.*





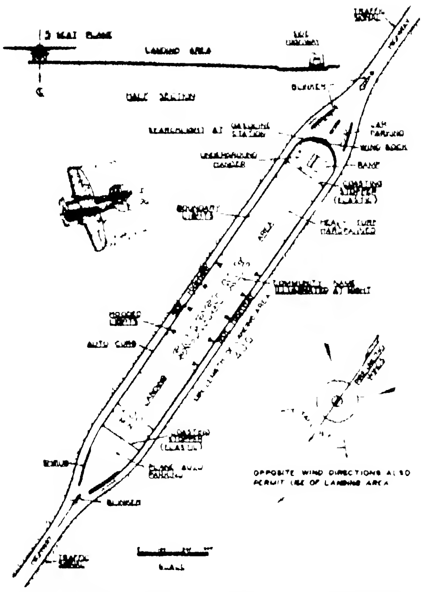


Above: **Comparative frontal areas of in-line and radial airplane engines.** *Right:* **Front and side views of the new Ranger engine for private planes**

A Novel Form of Landing Field

IN the expenditures shortly to be undertaken by the Government on such a lavish scale, the construction of a large number of airports might well be considered. Grover Loening, whose book is reviewed elsewhere in these columns, advocates as part and parcel of the great highway system now being planned, the allocation of funds to an airport system. Every ten miles or so, along the nation's highways, there should be a reasonably good landing field, say about 2000 feet square, right alongside of and connected with the great highways. Such a network of airports, say 10,000 in number, would cost about 200,000,000 dollars and would open to flying many mountainous and swampy sections of the country. Near almost every large city there is an airport of some kind. What the private flyer now needs is not an extension of such large airports, but a greater number of smaller, intermediate fields, conveniently located.

Directly in line with this suggestion is a novel form of landing field designed by an airport engineer, A. W. McKaig, illustrated in our drawing on the following page, and termed "Aeroplot."



The "Aeroplot" aircraft landing field

The "Aeroplot" would involve merely a widening of a section of the highway right-of-way to a minimum width of 200 feet on a length of 1400 feet. Airplanes would be permitted to land or take-off during the night or day on this area, within two lanes of highway or parkway without interference from traffic. Semi-automatic highway traffic stop signals would be located beside the highway at a suitable distance from both ends of the landing areas. At the time of a take-off or landing, the field attendant would stop all highway traffic. The signals might also be operated by the pilot of a plane through a tuned buzzer or siren signal from the plane which would actuate a tuned and timed receiving switch located on the premises and connected with the highway traffic stop signals. It is also possible that full automatic actuation of the signals might be possible by using plane detectors adjusted for duration and distance.

The landing areas would be best located at such a point on the highway or the parkway where the right-of-way parallels the direction of the prevailing wind. An adjacent landing area would also be located where the highway is at 90 degrees to the prevailing wind, and at the proper gliding distance from the first intermediate field. In this manner every contingency of weather and wind would be provided for in the most economical manner.

The concessionaires for gasoline, oil, and so on would serve both airplanes and automobiles.

The details of the scheme are sufficiently indicated by the drawing, on which are marked boundary lights, hooded lights, blinkers, elastic coasting stoppers, ramps, underground hangars, and so forth.

Mr. McKaig's plan is the result of many years' experience in airplane operation and airport construction and deserves study. —*A. K.*

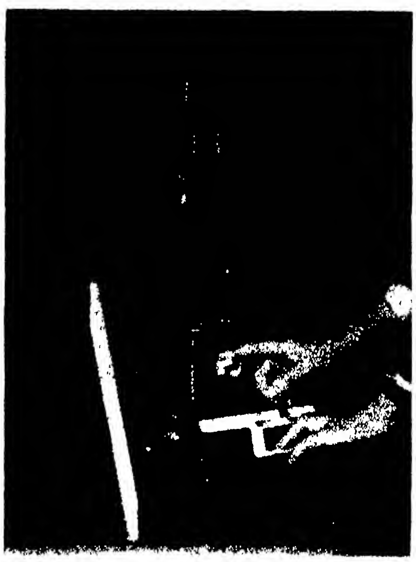
Pectinized Malted Milk

An old favorite, malted milk, may be given a new twist by the addition of pectin, it has been discovered by California Fruit Growers Exchange, Los Angeles. Pectin provides the creaminess usually obtained by the use of ice cream. In the soda-fountain malted, it may replace all or part of the ice cream. In packaged malted milks intended for the home, in which ice cream commonly is now used, it has even greater possibilities. The pectin is put into the malted milk either by mixing the two materials as powders or by adding a pectin solution before reducing the milk to a powder.—*A. E. B.*

Warning Deters False-Alarm "Bugs"

A device that sounds a loud warning signal simultaneously with the "pulling of the hook," and can be conveniently mounted upon the peaks of existing municipal fire alarm boxes, is a recent contribution to the war on false alarms.

This little device with a big and raucous voice, not easily confused with automobile horns or other street noises, is known as the Arrestolarm. When the alarm is operated, the down pull of the lever trips the mechanism of the Arrestolarm to sound a raucous signal of a minute's duration. A convenient winding handle is provided for the use of the fire department member who is charged with the rewinding of fire alarm boxes after each alarm.



An alarm that prevents false alarms; warning bell mounted above fire box

It is not expected that this "howler" will completely eliminate false alarms, but it is felt that it will tend to reduce the number from the most troublesome false alarm spots by attracting the attention of police, passersby, or local residents to the box in time to observe the culprit.

Fever as a Friend

The idea of a doctor trying to give his patient a fever would have seemed revolutionary and crazy in our grandfathers' time, when every effort was bent toward driving the fever out of the sick body. Now it has become a friend, something with which to fight and cure diseases. Since the Viennese physician, Wagner von Jauregg, found that the high fever of malaria was curing syphilitic infection, medical scientists have used malaria and many other means to induce fever in the treatment of disease. By electricity and by short radio waves and by prolonged hot baths they have deliberately raised their patients' temperatures to what once would have been considered dangerous levels. The latest tool for producing fever is, strangely enough, air-conditioning, hailed originally for the relief it brought from uncomfortably hot summer weather.

The idea of how fever brings about a cure has changed, too, even in the short time that it has been used as a form of treatment. Medical scientists first thought the high temperatures killed the disease germs. Dr. F. W. Hartman, of the Henry Ford Hospital, Detroit, explained in demonstrating his air-conditioning apparatus for inducing fever that in his opinion the fever acts by stimulating the defensive mechanism of the body.

The air-conditioned chamber raised the body temperature to 103 degrees, Fahrenheit. Dr. Hartman and his associates, Drs. R. J. Major and H. P. Doub, believe it is better than any of the other methods for elevating temperature because it is more easily controlled. While it is not yet on the market, they estimate that it can be made for about 250 dollars.—*Science Service.*

WIRELESS!

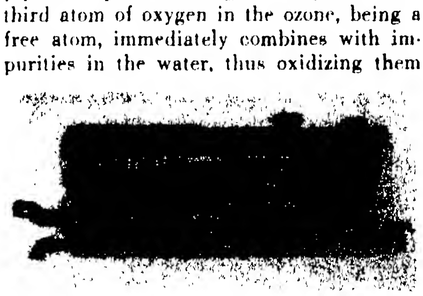
More than 45,000 miles of special telephone circuits are in use every day in connection with radio broadcasting in this country.

Residential Water Ozonizer

We had occasion in our January, 1932, issue to describe an outfit for purifying water in rather large quantities for swimming pools, large buildings, and the like, by the ozone process. This process has now been adapted to a smaller unit which can be used to purify residential water supplies. The new unit is 19 by 8½ by 6½ inches—small enough to be placed over any sink or water drain.

Electrical current at 110 volts is taken from the household wiring system and stepped up to 8500 volts. This is connected to an ozone generator which consists of a glass dielectric separating two electrodes, one of aluminum and one of copper. Between the aluminum and the glass dielectric is a small space to permit the passage of air. The corona discharge between the two metal plates passes through the air in the space between, thus converting some of the oxygen into ozone.

This manufactured ozone is then thoroughly mixed with the incoming water supply as it passes through an injector. The third atom of oxygen in the ozone, being a free atom, immediately combines with impurities in the water, thus oxidizing them

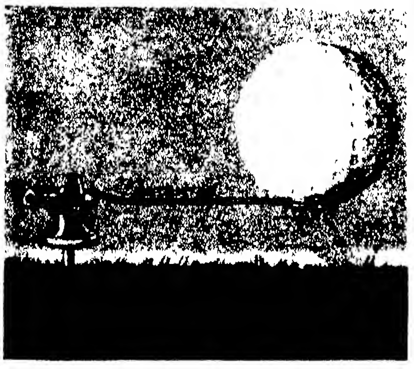


Water ozonizer for the home

and transforming them into harmless substances. It will destroy bacillus coli, most other bacteria found in water, micro-organisms of all sorts, objectionable odors, colors, and tastes arising from vegetable or other organic origin. Ozonized water is, therefore, palatable, odorless, and tasteless, the excess ozone being allowed to escape in a column of the device.

Golf Tee that Spins

ONE of the latest inventions for the golf player is the Grigg Spinner Golf Tee, illustrated here. It was originated by an individual who gave serious thought to improving the primitive golf tee. The tee is machined from brass, nickel plated and polished, making it durable and rustless. It holds the ball at the right height and spins free of the ball when struck. It folds up and can be neatly tucked away in bag or pocket.



Sugar Tablet Tabs

A SUGAR refiner has adopted for wrapped sugar tablets a tear-open tab that enables diners to get at the sugar without undue fumbling. Credit for this long-needed development goes to American Sugar Refining Company, manufacturers of the Domino brand, says *Food Industries*.

Rubber in Mattresses

OF all recent rubber developments, the new product called "NuKraft" is unique. NuKraft is rubber-insulated hair cloth fabricated into loops forming a series of figure eight springs. It is used as spring decking for inner spring mattresses. The rubber ages well, not showing any appreciable deterioration when artificially aged for a period representing about 10 years of actual service. This product is vermin proof, sanitary, and free from objectionable odors. NuKraft bridges the openings between springs and evenly distributes the weight. It not only provides additional springing but eliminates the necessity of tufting to keep the material in position.

The Black Widow

THE black widow spider is more deadly to its own kind than to mankind. The female of the species, the worst biter of the family, usually eats her mate and often her young. She attacks human beings only if they irritate her when she is hungry. A well-fed black widow spider is anything but aggressive, according to Dr. F. C. Bishopp, of the United States Department of Agriculture.

This spider bites humans infrequently,

(*Please turn to page* 45)

THE AMATEUR ASTRONOMER

Conducted by ALBERT G. INGALLS

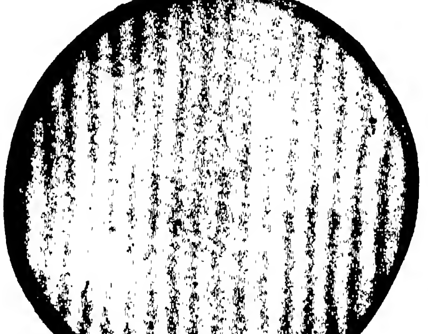
IS it some kind of big bug, or is it a Mesozoic dinosaur, all set to spring at you? These are some of the things which the unique telescope shown below looks like when you are dreaming of it. Horace H. Selby, a chemist for Hage's, a dairy products company at 9th and K Streets, San Diego, Calif., sent the photographs, with the following letter:

"For many years I have been interested in optics. I have computed and constructed two microscope objectives, one condenser (N.A. 1.32), two photographic lenses, and one 60 mm. apochromatic, three-element telescope objective. All this before last year. Then I chanced to meet the Lowers, local Tychonians, and my downfall was assured. They had a 12-inch reflector. I decided to build a 12-inch, and to do it backward. First, I made the mounting, placed in it two flats which I had made long ago, and used the 60-mm. objective. See photograph."

And now it is time to explain this telescope a bit. The picture at the left shows the counterweight turned up, and the temporary telescope in its baffled hood turned down. When in use, these are reversed, as in the right-hand picture, and the objective, shown turned earthward in the left-hand picture, is turned heavenward, as in the other. The optical train is: Through dark hole to a 60-mm. O.G., to a diagonal flat behind O.G., down to a second diagonal flat in the big pipe cross, and back up to the eyepiece which you see in the picture, on the head end of the dinosaur's body (the polar axis). Now imagine a 12-inch Cassegrainian mounted in place of the temporary box and O.G. part, and you have the job as Selby intends to complete it. This is the first time we have published an unfinished job, but it is an interesting one. Now to return to Selby's letter:

"Next," he says, "I made three 31-cm. flats on Pyrex, five surfaces of which were flat to about 0.1 wave, except for quarter- and half-wave edges. That was three months ago, and these surfaces have now changed, one by 0.4 wave. I then made eight more flats, for fun. Next I made an $f/1$ sphere for testing the Cass hyperboloid, à-la-Hindle."

We wrote to Selby for more details about his telescope and here is the answer: "The base is of 3 : 2 : 1.5 concrete, in two piers, 3 by 1.5 by 4 feet deep. This holds the grasshopper legs, of 2" extra-heavy wrought iron (E.H.W.I.) pipe, which support the mount proper. The polar axis is of 4"



One of Selby's numerous flats. Its edge has *not* been diaphragmed out

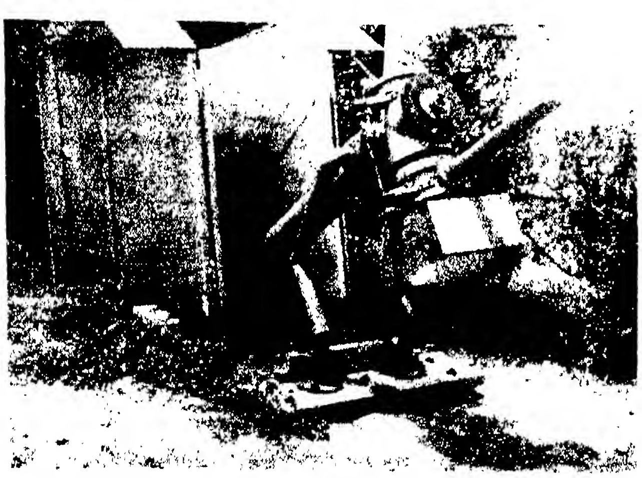
E.H.W.I., within the 6" E.H.W.I. body, and runs on two roller and two ball-thrust bearings. The bearings contain 160 quarter-inch rollers and 160 quarter-inch balls. They are housed in two 6-6-2-2 crosses. The head is constructed of one 6-6-6-6 cross, one 6-6-2 tee, one 6" close nipple, one 4" by 6" nipple, which is the declination bearing, a 4" by 15" flange and a 6" to 4" bushing with lock nut. The counterpoise, a 4-4-2 tee with plugs and lead, is carried by 2" E.H.W.I. pipe. All construction and design are my own, but such heavy lathe work, done at night on a borrowed lathe, caused me many a back- and headache. No machinist, I took a hundred hours to do what an expert would have done in 25, but it was fun, and the finished job is rock-steady at 300 diameters, even when slapped, and the movements are very smooth and precise. By means of four hand-wheels, which are always within reach, the fine and coarse declination adjustments can be performed while observing, as can the fine polar movement.

"The optical system comprises a baffled hood, 12" long, a 7-cm. apochromatic triplet, two flats, and a series of eight oculars from 50 to 2.5 mm. *e.f.l.*, all of my own construction and computation, save two oculars —a 2.5 mm. Beck and a 7 mm. Tolles. The performance is good. Dawes' limit can be reached with the greatest ease. Using a microscope giving 200 diameters per inch of aperture, star disks are round at focus, and on the rarely-found fine evening the extra-focal images show clean, sharp ring structure.

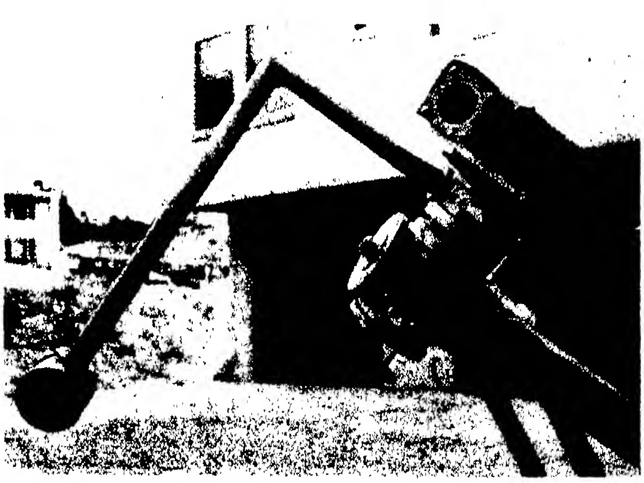
"The mount is for the 30-cm. Cass, which is not finished, and is a hybrid embodying some features of the Coudé, Repsold's overhung astrograph, the Springfield, and Ritchey's 60". The stationary eyepoint is Coudé; the counterpoise is Springfield; the undercut mount, which will clear the Cass in any complete revolution, is Repsold, as is the complete visibility of every point in the sphere; and the hollow polar axis, for very long equivalent focus work, is Ritchey."

Commenting on Selby's telescope, Harold Lower says: "The present objective is a triplet, and is a fine job. Selby knows his stuff. He has also built a grinding machine."

A NEAT, unusual job is a reflector, apparently of about 12-inch aperture, made by Chester A. Howard, president of the Dallas Astronomical Society, 3120 Princeton Ave., Dallas, Tex., assisted by C. H. Huvelle, N. E. Bucklin, and Dr. Langenour. "The whole job," Howard writes, "is just like Gibraltar, so far as vibration is concerned. Both axes rest on double rows of SKF ball bearings, self-alining and made for thrust as well as bearing. Size of polar axis 2¾", dec. axis 2¼". The weight is 640 pounds, not including the concrete pier. The castings are iron, except the saddle and prongs, which are aluminum. The hand wheels are brass and the one at the upper right rotates the tube on ball bearings—one of the greatest features, I

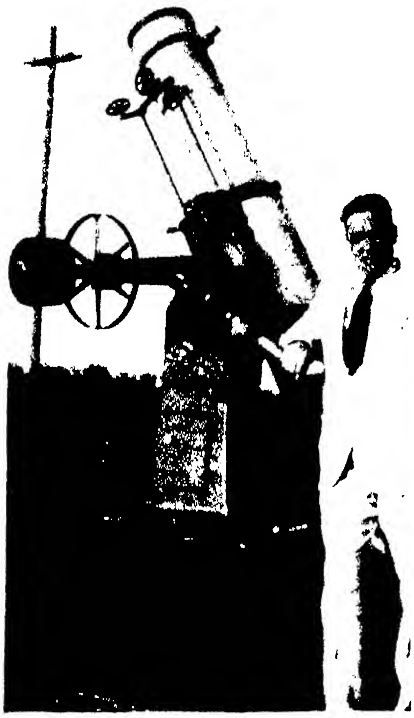


Selby's tame dinosaur, with its head down and tail up



The same telescope in working position. A rigid mount

believe, to be had on any reflector. I see very little if any of this feature on the many instruments shown in the magazine." This handwheel, which Howard mentions, works a longitudinal shaft, through bevel gears, and this shaft in turn works a spur gear which shows in the picture, the latter turning the tube by means of an encircling spur gear. It is all very professional—the



Howard and the Dallas telescope

whole job commendable particularly those heavy 2¾" axis shafts. And—"rock steady."

PARTS like those described by Selby and by Howard—extra heavy wrought iron pipe legs and six-inch pipe fittings, also 2¾" axis shafts—mean real rigidness, rigidity, or "rock-solidity." In a recent letter, Ellison mentioned that some of the mountings he had seen described in this department seemed to be "whippy," and he is right. A telescope which magnifies 50 or 100 times, also magnifies vibrations in exactly the same measure; so that the builder should always think of the vibrations caused by the breeze as if the telescope tube were extended to about 100 feet in length, and he were trying to obtain a steady look. Some of the mountings we have seen might as well be built on a buggy whip tied to a fish pole, as on the thin little axes, skinny and anemic, which they have. Wallie Everest got us stirred up enough to write these ugly comments, saying "Give 'em Hell about it," and this is it.

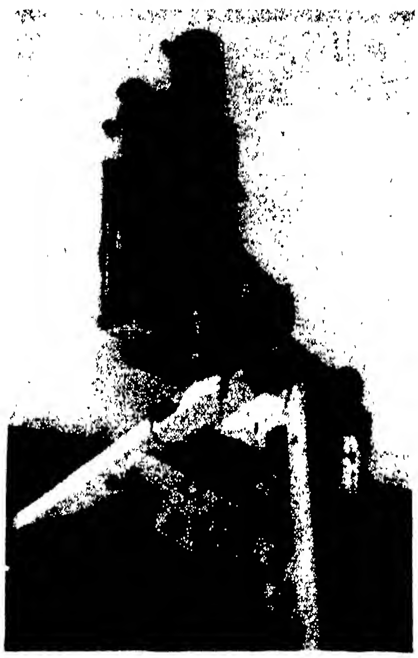
While we are at it, we will get off our chest another pet peeve that burns us up and temporarily wrecks our sweet (?) disposition every now and then. This is the matter of photographs. At a casual glance the average photograph seems to be in focus, but close scrutiny of many show that this is not true for the whole depth of the telescope photographed. A dodge for this is simply to stop down to about 32 and take a time exposure. Result: whole telescope in sharp focus.

AND now, while we are speaking about rigidity, look at the forks on the two

telescopes shown in the photographs below. W. A. (Bill) Mason writes from 1303 Lakeview Ave., Lorain, Ohio, that the Cass with the short finder (left) belongs to John Clouhessy, a machinist, and the other is his own. They are nearly the same, John Clouhessy's having 190" f.l. and the other 170". "I did all the machine work," he says, "and made the castings, all being of aluminum. We also made our own patterns." Co-operating with these two were Jim Clouhessy, machinist, and Dick Curran, molder.

The main features of these jobs are: 12½" Pyrex primaries, 39" f.l., and 3¾" secondaries. Pyrex diagonals 0.1 wave. Screw-focusing eyepiece holders with ⅛" double acme thread. These swing around ends of tubes, for convenience. They will take up to 2" O.D. eyepieces. Lower half of tube of each telescope screws off the trunnion ring, and contains the cell. Slow motions in dec., worm gears—same for R.A. Drive: governor-controlled induction motor ("Green Flyer"): worm gear reductions, made by John and Jim, 30:1 and 24:1. Timken roller bearings. Polar axes, 2¾" diameter. [Ha! Same size as on the Dallas job. This one won't quiver, either.] Both axes can be slipped on the slow motions. Weight of each job about 180 pounds, 125 of this being aluminum.

WILLIAM S. VON ARX of 573 Monroe St., Brooklyn, New York, writes: "Several years ago I purchased my now well-thumbed and tattered copy of A.T.M. Greedily I soaked up its contents and set to work on the inevitable six-inch Newt. Success greeted my first attempt at parabolizing and I immediately branded myself a born optician. With the heavens plopped in my lap, so to speak, I spent many hours feasting my eyes on the splendors above. Then I was suddenly gripped with the desire of photographing these wonders. Night after night I lay awake planning a suitable equatorial drive and camera. Finally I reached what I considered a perfect solution and set to work. Within the year I had completed the drive, camera and other necessaries and found on trial that I didn't know two twits about what I was trying to do, so I took the whole thing apart and started all over again. This has occurred five times within the past four years [which means he started at about 14. *Ed.*] and now I think I have achieved my goal in the result which you see in the enclosed picture.



Bill von Arx's collection, mounted on a wooden "saw horse." See story

"It is a fork type mounting, driven by a disk motor and an elaborate gear speed reducer. In the fork are two cameras and three telescopes. A three-inch glass of short focus for guiding, whose triplet objective made me recant my former pride as an optician, and a one-inch finder for it, then a 1½-inch telephoto camera giving an equivalent focus of 37½ inches and a finder for it. All these things are mounted on the primary camera, which is an *f*/4.5 of 12 inches focus. This lens is the only one I bought; all the others are home-made, because I found with experience that lenses are expensive.

"With this equipment to start with, I gradually added gadgets, such as flap shutters, objective prisms, and so forth, for the cameras, and a polariscope, Zollner eyepiece spectroscope, iris diaphragm, micrometer eyepiece, a set of filters, zenith prism, and several high-power and one ultra low-power eyepiece for the three-inch guiding glass. With things arranged in this way my equipment is equally effective, either visually or photographically. And, too, with the accurate drive, diaphragm and trick eyepiece, it lends itself admirably to both lunar and planetary detail.

"This trick eyepiece I believe deserves a bit of explanation. In essence it is a disk with eight lenses in it, each lens of higher power than the one preceding it. Thus it might be called an octo-revolver. The lenses of the whole series are negative, thus making the telescope Galilean. When the power of the negative ocular gets as high as those I have put in this turret, the field is not reduced, as is usually the case in the low-power negative ocular. The angle of the field is as large if not larger than an equivalent Huygens ocular. The lenses in this turret are double concave, with radii of curvature ranging from 1½ mm. to less than ½ mm. Needless to say, I nearly lost those pinhead lenses under my finger nail a score of times, but after much sweating and rather noxious language, they found their way to their respective cells. With a bit of stopping down with the diaphragm, and careful focusing, lunar and planetary detail pops out surprisingly well for such a small glass. Then, too, the accurate driving helps enormously by keeping small objects accurately centered in the field.

"This drive, which I have fashioned after much experimentation with varied forms, is the most satisfactory I have ever used. It will keep a guide star centered accurately enough to get round images with the 12-inch camera up to two hours exposure. The 37½-inch holds true for three quarters of an hour or more without guiding.

"One ever-present difficulty in photographing the heavens is dewing. I overcame this difficulty by placing a 1000-ohm resistor in the hood over the lens. The heat of the resistor was sufficient to keep the air above its saturation point, and thus prevented dew from forming on the cold surface of the lens. Now, when I find dew forming, I merely throw a switch and it clears within two or three minutes.

"Another gadget is a field illuminator which facilitates seeing the spider lines in the reticule of the guide telescope. I have a little variable resistor that doctors use for opthalmoscopes, and so on, that gives from 0 to 6 volts variable output. This, in connection with a 6-volt bulb in the tube of the telescope, gives any light brilliancy desired."

Harold Lower says von Arx's photographs are the best he has seen.

THE tenth annual get-together and convention of amateur telescope makers will be held at *Stellafane*, near Springfield, Vermont, on Saturday, August 3. For details, if you don't know about these informal pow-wows already, write to R. J. Lyon, secretary, The Springfield Telescope Makers, 252 Summer St., Springfield, Vt. Come, if interested in telescopes, but leave your tail-coat in moth balls.

Messrs. Clouhessy (John), Mason, Clouhessy, Curran

The same two Cassegrains as are shown at the left

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 41)

but its bite is more poisonous than that of any other North American spider. As the insect has recently extended its range westward and northward from the South, where it is better known, and as it is hard to tell a hungry spider from one that has just had a good meal, Dr. Bishopp offers a few suggestions for destroying the black widow spider. The best thing, he says, is to spray with creosote oil the spots she frequents—garages, woodsheds, privies, and other outbuildings, as well as wood, brick, and stone piles, and manholes and culverts. She seldom enters houses. Gloves are a great protection in working around places where this poisonous pest may lurk.

[See also page 181, October, 1934, and page 228, May, 1935, SCIENTIFIC AMERICAN.—*Ed.*]

LIGHT METER HAS RANGE MULTIPLIER

A DEVICE now available for increasing the range of the Westinghouse light meter consists of a light absorbing screen which absorbs nine tenths of the normal light and transmits the other 10 percent to

A screen for light meters that multiplies the range to 10 times normal

the photo cell. To increase the scale range of the instrument to 10 times its normal capacity for the purpose of measuring higher light intensities, it is only necessary to clamp this translucent screen in front of the exposed surface of the photo cell.

"INVISIBLE GLOVES" KEEP HANDS CLEAN

CHEMISTS have now invented invisible gloves that anyone may put on with assurance that they will keep his hands clean even while he is doing the dirtiest of jobs. These "invisible gloves" come in a can and look like cold cream. But when you rub this cream over your hands it disappears, forming an invisible film which prevents dirt, grease, paint, and so on, from entering the pores or adhering to the skin. You won't know you have the invisible gloves on, for your skin feels dry and is free from any feeling of stiffness or greasiness. Then, when you have finished your work, you remove the "gloves" by rinsing

your hands in water, thus removing dirt and "gloves."

This unique invention is to be sold under the name of "Pro-Tek." It is not a soap, but a protective cream, entirely harmless and non-irritating to the skin. It is being widely adopted by plant physicians and executives for use by mechanics and factory workers, and is also filling a need for painters, printers, garage mechanics, service station attendants, railroad men, pipe fitters, coal handlers, miners and others. There are also expected to be many uses for "Pro-Tek" around the home—for odd paint jobs, polishing the auto, cleaning out the furnace, gardening, and general housework.—*A. E. B.*

CANARIES

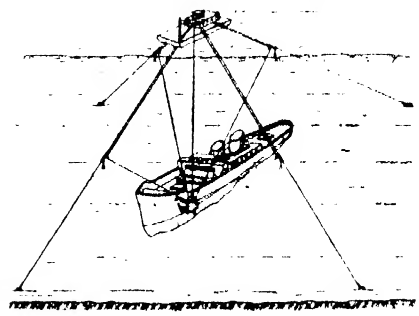
CONTRARY to popular opinion, canaries do not have to be taught to sing by an adult male songster. This is shown by an experiment at the University of Southern California where 12 roller canaries were hatched and raised in sound-proof cages. All developed an adult singing ability.

SALVAGE BATHYSPHERE

DOCTOR BEEBE'S now famous bathysphere permitted a visual exploration of the depths of the ocean. A new one recently tested at Washington, D. C., seems to give promise of extensive salvage operations at great depths. This new one, shown in the accompanying illustration, was developed by the Romano Salvage Corporation of Seattle. It has already been tested at depths greater than 800 feet and, according to reports, Navy inspectors called it "the greatest invention since the diving suit."

The Romano diving ball is made of steel sufficiently strong to stand pressures at a depth of half a mile. It owes its usefulness to a variety of arms and searchlights, all operated from within. Twelve different attachments can be used in connection with these arms with which, it is said, the operator can lift objects weighing half a ton, tie knots in one and one-half inch steel cable, drill holes up to three inches in diameter through ships' plates, and perform a variety of other tasks under water.

In operation, four anchors with attached cables are sunk at the four corners of a



How the mother ship of the salvage bathysphere is anchored over a wreck

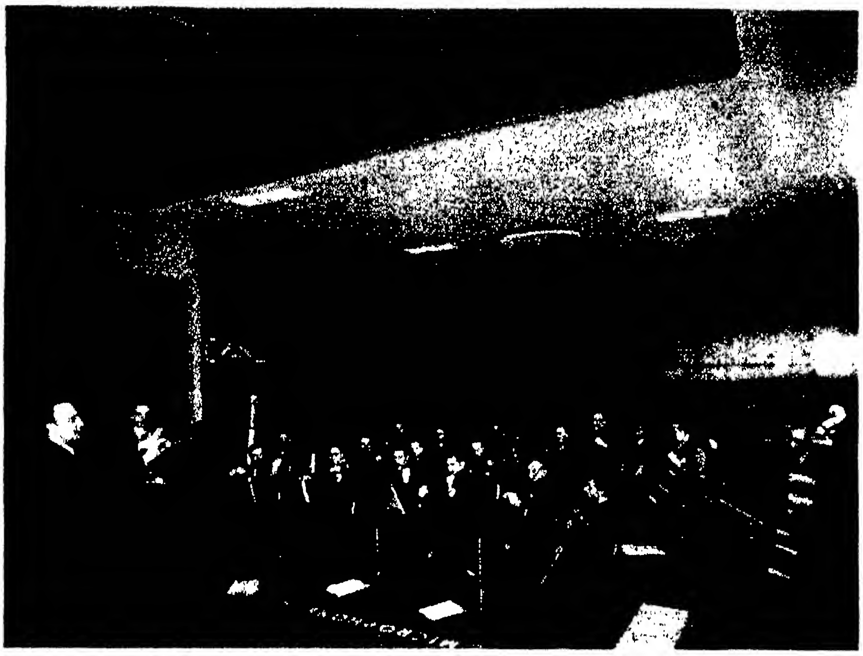
given area which may be 1000 feet on a side. Four lines thus fixed meet at the mother ship. From the underwater tent-like cable structure hangs the diving ball. With this control the ball can be moved up, down, or sideways.

Already there has been much talk of going after some of the billions of dollars' worth of golden treasure that have been lost at sea in years gone by.

NEW TECHNIQUE IN RADIO STUDIOS

A "PICK-UP" technique entirely new to radio is now being employed by the Columbia Broadcasting System in one of the main studios of its key station, WABC, in New York. The studio is of the so-called "live-end, dead-end" type, but is revolutionary in its use of a special echo plane instead of a mere reverberating surface on the rear wall of the "live end." All three wall surfaces of the "live" portion are covered with wood paneling designed in ac-

The salvage bathysphere, showing the flexible arm and one of the attachments



Scientifically designed walls make possible a new technique in broadcasting

cordance with acoustic principles, a construction technique never before used in a broadcasting studio.

The studio's "dead end" walls are covered with two grades of perforated metal designed to permit the sound to penetrate to the 4 inches of absorbent rock-wool beneath. The windows of the control room and client's booth, situated in this end of the studio, are long and narrow in design to cut to the minimum any reflections that might be set up by the glass surfaces.

The wooden panels of the echo plane, instead of being fastened solidly to the wall surface behind them, are secured only at their edges, leaving their centers free to vibrate as the sound strikes them. The action of these panels, in reflecting the sound coming to them from the performers at the other end of the studio, tosses the sound waves back to the "pick-up" point as an echo. The time required for this return, however, is only a small fraction of a second and results in an unusual brilliance of tone. The fact that the sound vibrations drop off more abruptly than they would if reflected by reverberating walls also enhances the tonal brilliance.

In addition to the single echo plane, other reverberation surfaces are provided and built in undulating surfaces so that the sound waves will be diffused as they are reflected from side to side of the room.

The use of wooden paneling for the live surfaces was suggested by the fact that musicians have for many years claimed that their music sounds better to them when they play in wooden paneled rooms than in any other kind. The paneling performs much the same service as the sounding board of a piano or the back of a bass viol. In planning the studio the technicians decided to treat the entire room as though it were a single large musical instrument.

How Many Alcohols?

HOW many kinds of alcohol are there? The average layman will probably reply: "Two kinds—grain alcohol and wood alcohol." Actually there are more kinds of alcohol than industry knows what to do with. Many new types have been developed since the depression. Allyl, cetyl, lauryl, octyl, are a few of them. In the aliphatic family alone there are 23 different alcohols now commercially available, all of which can be made synthetically. Uses for many of them are now being worked out in the laboratory. Alcohols that were either unknown or were only of academic interest a decade or two ago are now being produced on a large scale and are indispensable to hundreds of industries.—*A. E. B.*

EXPLOSIVES

FOR the eleventh consecutive year, enormous tonnages of explosives were carried in 1934 without injury to a single person. The amount of dynamite and black powder, both commercial explosives, transported last year was something more than 300,000,000 pounds.

Liver Extract Low in Price

A MARKED cut in the cost of the liver extract treatment for pernicious anemia was announced by Dr. William P. Murphy of Harvard Medical School before the last meeting of the American Chemical Society. Dr. Murphy also described how the technique of liver treatment for pernicious anemia has gradually changed.

At first he said the patients had to eat large quantities of liver each month. The dislike of many people for the taste of liver then led, he said, to the development of a powdery extract, which could be taken by mouth. The taste was not as obnoxious as liver itself but because it was only about 60 percent as potent as liver, large amounts had to be taken.

The new development which Dr. Murphy described consists of a highly potent and concentrated liver extract fluid which can be injected directly into the body muscles of the legs or arms, as insulin is injected

for diabetes. Clinical tests indicate that average patients need but one such injection a month to live a normal life.

The relative costs of the three methods of treating pernicious anemia, Dr. Murphy declared, run as follows: 5000 grams of whole liver a month at a cost of about $5.50; the extract in an amount equal to 8400 grams of liver at a cost of $17.00; the injections at a cost of $1.17 a month.—*Science Service.*

Treating Cloth to Shed Water

FABRICS that rival the traditional duck's back in ability to shed water are now produced by the use of a new chemical product developed by E. I. duPont de Nemours and Company, and marketed under the name "Aridex." It is a white, waxy emulsion for use in producing a water-repellent finish on textiles of all kinds; also for impregnating silk, rayon, cotton, linen, or wool and for treating leather and paper. It is an outstanding development in this field and is being rapidly adopted by textile processers who have a demand for waterproofing of any sort.—*A. E. B.*

All-Wave Hotel Radio

AN elaborate all-wave radio reception antenna designed by the engineers of the Bell Telephone Laboratories is one of the unusual features of the all-wave radio receiving system now being installed in the Waldorf-Astoria Hotel, New York City. Two strands of wire in this antenna cross to form a huge "X", while a third resembles an inverted "U". The strands are of different length and each responds to waves in certain bands.

The aerial has been designed to reduce to a minimum any interference which might ordinarily be experienced in all-wave reception. It is so orientated that the wires are strung broadside to those parts of the globe where the majority of the short-wave stations are located, this being the best position for reception. The accompanying map, a gnomonic projection, shows the antenna located at New York and the true, straight-line distance and direction to any point on the globe.

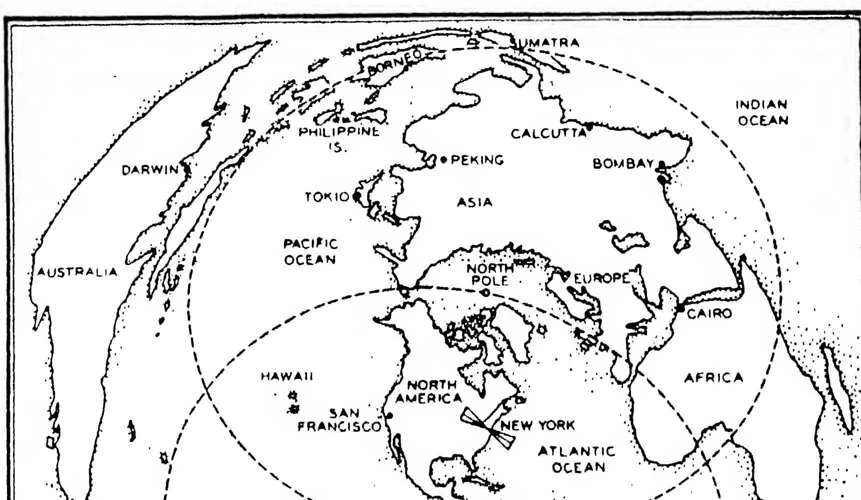
DERMAL NITRATE

DETECTIVES may now identify the hand which has fired a gun by the "dermal nitrate" test. Almost invariably tiny particles of unburned powder, largely nitrate, are deposited in the hand of the person who has fired a revolver. These can be "developed" as violet spots by means of chemicals.

Fire-Proofing Airplane Fabric

A SIGNIFICANT contribution to safety in the operation of aircraft was revealed by Gordon M. Kline of the United States Bureau of Standards at a recent meeting of the American Chemical Society, when he announced the perfection of a fire-proof "dope" for the treatment of airplane wing fabric. Cellulose nitrate dope is now commonly used to cover the fabric on the wings and fuselage of airplanes. Being made from nitrocellulose, or guncotton, this coating is extremely inflammable. The newly developed treatment consists of the application of a three to seven boric acid-borax mixture to the airplane cloth and subsequent "doping" with cellulose acetate.

During the World War, consideration was given to the use of cellulose acetate as a substitute for inflammable cellulose nitrate for doping airplane wings but because of the higher cost of the acetate and because of the remarkable technical development of nitrocellulose lacquers, cellulose acetate gained little acceptance. Recently,



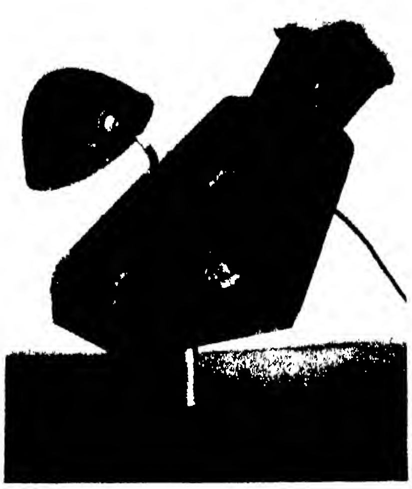
A gnomonic projection of the continents, showing how the new hotel radio aerial, described above, is located for best reception from the majority of transmitters

however, technical improvements in the manufacture of cellulose acetate have brought about an improved and much cheaper product so that today the acetate dope is only slightly more expensive than the nitrate.

The borax-boric acid mixture is the best fire-retardant so far discovered by the Bureau of Standards in a long series of experiments with such substances. Tests on actual planes have established the fact that this treatment has no deteriorating effect on the airplane fabric. —*A. E. B.*

Fluorescence Cabinet

THE fluorescence of substances under ultra-violet radiation is a valuable method of laboratory analysis. It is particularly suitable for identifications of dyes and detection of adulteration of oils, forgeries, and secret writings. The instrument illustrated is a very flexible piece of equipment for this work. It consists of a light-proof cabinet with a fur-lined opening for viewing the interior. It is equipped with a window over which is placed a filter which permits only the invisible ultra-violet rays to fall on the sample which is placed on the floor of the cabinet.



New laboratory cabinet for use in examining fluorescent substances

A very small incandescent lamp is placed within the cabinet. This lamp, controlled by a rheostat, makes it possible to illuminate the sample with very faint visible light, while the more powerful ultra-violet rays are falling on the sample after coming through the filter. This makes it easy to locate fluorescent particles. The outfit is provided with a lamp which supplies considerable energy in the near ultra-violet region of the spectrum.

Drives Golf Ball through 'Phone Book

ALEX EDNIE, pro at Shelter Rock Country Club, Long Island, recently drove a Spun-Latex ball through a 'phone book almost an inch thick and containing more than 500 pages.

Standing the book on end without support, four feet in front of the tee, Ednie sent the ball through with such force that it carried and rolled 100 yards beyond. Traveling at the rate of approximately 114 miles an hour, the ball was averaging 167 feet a second when it hit the book.

A striking demonstration; a golf ball driven through and beyond a book

The drive, declared impossible by golfer and non-golfer alike, was made to test the new Spun-Latex golf ball, a U. S. Rubber product. Made of materials never before used in golf ball construction, the new ball is notable for its power and distance. These qualities are acquired primarily from a high-power winding of thread spun direct from liquid latex, the natural milk of the rubber tree.

MUSKRATS

ONE American visitor which Scotland does not like and which, in fact, has become a pest, is the American muskrat. Introduced to the British Isles some years ago, these animals have become so numerous and so destructive of dams and railway embankments that war has been declared upon them.

"Reach for a Sweet"

THE old slogan about reaching for a cigarette instead of a sweet may be all right for those who want to lose weight but for those who want to do some heavy thinking, it should be reversed. Experiments showing that the brain gets its energy for thinking from glucose or sugar were reported to the American Physiological Society by Drs. H. E. Himwich and J. F. Fazikas of Yale University. The brain takes sugar from the blood, breaks it up into simpler chemical combinations, and burns the lactic acid thus obtained to get energy.

Dr. Himwich and his associate found accidentally that when nicotine is mixed with brain tissue in a flask, the brain cannot burn lactic acid but the burning (oxidation) goes on just the same if glucose is present. So it appears that the brain has two ways of getting energy for thinking from glucose or sugar. Ordinarily it gets the energy via lactic acid, but if this is impossible, it gets the energy directly by burning the glucose.

The amount of nicotine that gets to the brain when a cigarette is smoked, however, is probably too small to affect the burning of lactic acid, Dr. Himwich explains. Incidentally, nicotine is not responsible for the increased sugar in the blood caused by tobacco smoking, Dr. Ephraim B. Boldyreff of Battle Creek Sanitarium reports.—*Science Service.*

Exit "Turps"—Enter "Dec"

"TURPS," the painter's old stand-by whose full name is turpentine, is now challenged by a synthetic product of reputed superiority known as "Dec," whose full name is decahydronaphthalene. Although not a new compound, "Dec" has only recently been prepared on a commercial scale at prices competitive with natural wood turpentine. Its chemical formula is $C_{10}H_{18}$. It is a water-white liquid with an odor similar to turpentine.

According to the manufacturer, Imperial Chemical Industries, Ltd., it may be used with advantage to replace turpentine as a paint thinner, and also, in many cases, the most costly solvents which are today becoming increasingly employed. Such intrinsic properties as a very high flash-point, leading to a reduction of the fire risks normally run with the more usual thinner; an absence of toxicity shown by prolonged tests and practical use; and a solvent power of exceptional range where paint and varnish materials are concerned, are claimed for it by the manufacturer.—*A. E. B.*

New Portable Public Address System

A NEW portable public address and sound amplification system for moderate sized public places, compactly self-contained in a carrying-case and weighing only 28½ pounds, has been introduced by RCA-Victor.

This unusually adaptable unit, which anyone can put into operation in less than a minute, is particularly suited to the steadily growing market for an inexpensive though efficient portable sound system for such applications as window demonstrations in dealers' stores, counter-to-kitchen restaurant call systems, and for local fairs and carnivals.

The equipment has been designed so that actual operation is as convenient and foolproof as that of an ordinary radio receiver, it is said. It is only necessary to connect the power plug to a 110-volt, 50-60 cycle current supply, and plug in the microphone and speaker cables to set the system in operation. The loudspeaker, which is imbedded in the cover, may be separated from the rest of the carrying case and suspended from a hook within a 25-foot radius of the speaker cable. The microphone is of the close-talking type with 12 feet of extension cord to assure the minimum of wiring and the maximum of adaptability to varying conditions.

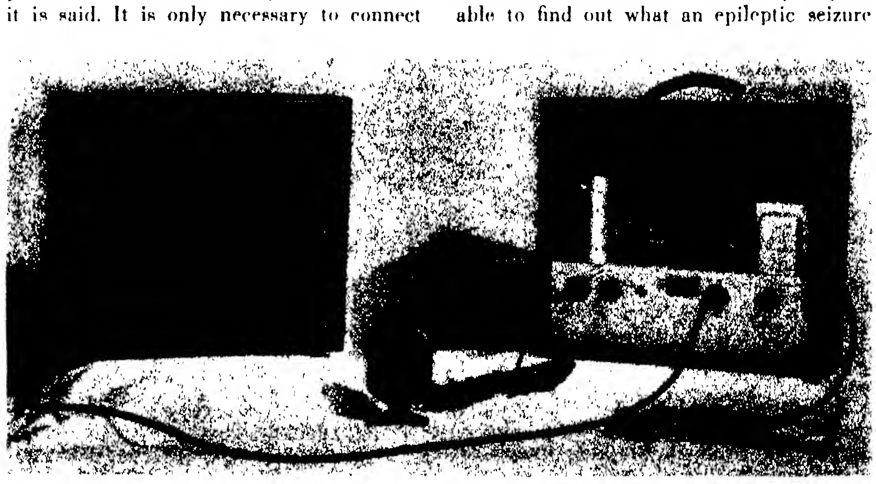
"Brain Waves" and Epilepsy

"BRAIN waves" tapped electrically are providing a new clue to the mystery of epilepsy, the first fresh lead to this disease problem that scientists have had in a long time. Drs. F. A. Gibbs, H. Davis, and E. L. Garceau of Harvard Medical School have reported to the American Physiological Society that an electrical hook-up to the brain producing wavy lines traced on paper gives a new clue to what goes wrong in this malady. They find by this means that epilepsy is probably a neurological storm which results in great piling up of electrical discharges.

The tracings of the small waves of electricity which come from the brain are similar to the now familiar electro-cardiograms which give physicians information about the action of the heart. Normally these small waves come from the brain at the rate of about ten per second. When a person is sleeping, in a faint, or loses consciousness temporarily in the strange sleep disease called narcolepsy, the brain waves are slowed down to about three to five per second and have about double the normal voltage.

In minor epilepsy, just before and during an attack, the brain waves come about every three seconds and in a strange pattern of large round waves with a spiky wave between the round ones. In major epilepsy, both fast and slow waves of much greater than normal voltage are found. Even more important, the disturbance in brain activity as shown by these tracings of the electrical waves from the brain goes on even when the epileptic patient is not having a fit or seizure and is in one of his apparently normal periods.

These changes probably hold the clue to what is going on in the brain at the time of a seizure and if they can find just what the waves mean in terms of nervous activity, the Harvard scientists believe they may be able to find out what an epileptic seizure

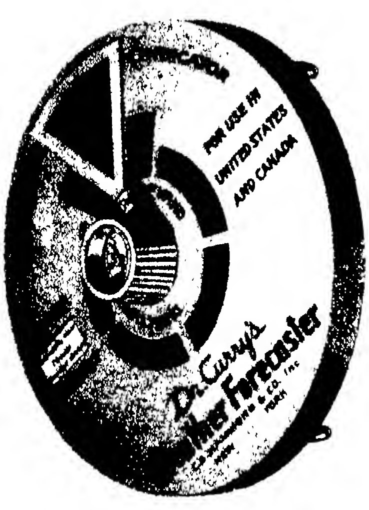


All the equipment of this new public address system weighs only 28½ pounds

is and how it starts. If they find that in some cases it starts in a part of the brain which the surgeon can get at, there might be a chance that the part where the disorder starts could be removed. This prospect is far in the future, however, Dr. Gibbs emphasized.—*Science Service.*

WEATHER FORECASTER

IT used to be that few people considered tomorrow's weather; they accepted it as it came. Some exceptions were, of course, fishermen and hunters, and, at harvest time, farmers. Forest service men or others in similar occupations were also vitally interested in weather because forest fires depend upon weather over long periods of time. Nowadays the motorist and the airplane pilot have changed the picture as both are vitally interested in the weather that tomorrow may bring.



An instrument with which anyone can make approximate weather forecasts by following directions

It is interesting to note, therefore, that Dr. Manfred Curry, a meteorologist and aerodynamist of note, an author and lecturer well known internationally, has perfected a simple and inexpensive instrument which is claimed to forecast accurately eight to 15 hours in advance. It is a pocket-size disk which sells for only two dollars and may be used by anyone.

This new instrument consists of a hygrometer employing a chemical which indicates the degree of moisture of the air by change of color. (Each color grade corresponds to a change of about 20 percent in the degree of moisture of the air. Of the five comparison colors, blue, for example, corresponds to an atmospheric degree of humidity of 0-20 percent and light pink to 80-100 percent.) Great humidity of the air, as a rule, brings rain, snow or fog; slight humidity, on the other hand, fine, dry weather. As, however, the degree of humidity in its effect upon the weather has to be estimated differently, according to the direction of the wind, a compass is provided, by means of which the cardinal points and hence the direction of the prevailing wind may be ascertained.

The changeable indicator is affected some 8 to 15 hours before a change in the weather sets in. By this means, you can forecast the weather for the next day. The barometer involves only one factor, the atmospheric pressure; Curry's Weather Forecaster bases its weather prediction on two factors, the atmospheric moisture and the direction of the wind.

This instrument is operated in a very simple manner by turning the knob of the disk shown in the accompanying illustration to match certain colors in the color segment, by determining wind direction as indicated by clouds, smoke, weathervane, or the compass, and then keeping the matched colors together and turning the knob slightly until the correct wind direction appears in the small window below the indicator. The correct weather forecast for the next 12 to 15 hours may then be read in the window on the left of the instrument.

YOUNG BIO-CHEMIST WINS RECOGNITION

THE first Eli Lilly and Company Award in Bio-chemistry, by unanimous vote of the American Chemical Society's committee, has been awarded to Willard Myron Allen of the School of Medicine and Dentistry of the University of Rochester, Rochester, New York. The basis for the award is the outstanding work done by Dr. Allen in developing a sharply defined biological test for the action of the corpus luteum, the use of this test to isolate in crude form a potent extract, and then the complete purification of the hormone now called "progestin."

Dr. Allen was born at Macedon, New York, November 5, 1904, took his B. S. degree at Hobart College in 1926, and was awarded a fellowship in chemistry at Brown University, which he declined in order to undertake studies at the University of Rochester in the School of Medicine and Dentistry.—*A. E. B.*

A BOOK OF PRIZE PHOTOGRAPHS

AS a result of a large photographic competition to be held in Europe, there will be published later this year "The Golden Book of the Rolleiflex." This book will contain the prize winning photographs and also outstanding examples of work done with Rolleiflex and Rolleicord cameras. Although the competition itself is limited to European photographers, American operators of the above-mentioned cameras are invited to submit photographs for publication in the book. The photographs submitted should be on glossy paper and should reach Burleigh Brooks, 127 West 42nd Street, New York City, not later than July 15th.

GLASS ETCHING

WE have just been having a lot of fun! Having purchased some attractive but plain table tumblers, we proceeded to etch a long-desired monogram upon them with new materials recently developed. First we cut a stencil of our monogram in aluminum foil, the back of which was coated with a sort of gummy cement. This stencil was pressed tightly to the glass and from a tube, resembling those in which dental cream is sold, a ribbon of glue-like substance was squirted over the stencil openings. After a matter of two or three minutes

the substance was washed off with plenty of warm water, the stencil was lifted, and we found beautifully frosted upon the glass an exact copy of the monogram which had been cut in the stencil.

The new material used in this case was Etchall, a product which seems to be as harmless as its manufacturers claim. Hitherto, as far as we know, there has been available no chemical other than the fluorides, which give off dangerous fumes and which should be handled only by chemists, to do such a job of etching. Sand blasting and other abrasive methods, of course, do the job satisfactorily but require rather elaborate equipment. Etchall, however, is about as simple and safe in most respects as tooth paste and is just about as cheap.—*F. D. McH.*

LONG OIL-FILLED CABLE

WELL over three-quarters of a mile long, the reel of oil-filled cable shown in the photograph is the longest of its kind ever made. Shown while being reeled in the General Electric cable factory at Schenectady, it is 4200 feet long, of 450,000 circular mils cross section, for 132,000-volt operation, and with an oil-filled hollow core. It weighs 22 tons net, with a shipping weight of 25 tons on its reel, which is 134 inches in diameter.

A three-quarter of a mile long oil-filled cable being placed on its reel

FICTION OF INDIAN CHIEFS

THERE have been few, if any, real Indian "chiefs," according to specialists of the Bureau of American Ethnology of the Smithsonian Institution. There are plenty of living Indians, of course, who have had the title thrust upon them. Some of them may even have thrust it upon themselves. But the fact remains that—at least until well along in the last century when the tribal political concepts were coming under white influence—there probably was no such thing as a chief from the Arctic Circle to the Rio Grande. South of that, in the supposed absolutisms of Mexico and Peru, the "chief" status is somewhat doubtful.

Certainly such men as Massasoit, Powhatan, Tecumseh, Sitting Bull, Geronimo, and other notable Indians whose names have survived in history, were by no means chiefs, in the sense of being rulers with legal sanction, either conferred or hereditary, for governing acts, according to Bureau of Ethnology specialists on the various Indian peoples. The Indians, so far as known, had no civil rulers. The organization of Indian society through much of North America was essentially anarchical—the anarchy being profoundly modified in different directions by religion, tradition, influence of individuals, and so on, but not by governing powers vested in any individual. Public opinion was the great determinant of conduct.

In the various tribes, certain individuals doubtless had very great influence because of strength of character, colorful exploits, exceptional intelligence, oratorical ability, wisdom acquired with age, or supposed supernatural visitations. Such a man often attracted many followers, who, because of their great confidence in him, may have accepted his word as law. Men like Massasoit and Powhatan probably were in this class. They were the outstanding individuals in their communities. Other Indians may have sought or accepted their leadership because they admired or feared them. But it was all purely voluntary. Such a man held no political office. He had no police power to enforce his commands—if he ever had the audacity to give any. Anybody—even his squaw in most cases—had a perfect right to disobey him at any time, and there was nothing he could do about it other than through his own personal prowess, or the purely voluntary assistance of some of his friends.

In war it was somewhat different. An individual, usually a man with various colorful exploits to his credit, would announce that he contemplated a war expedition for some specific objective. Those who trusted his leadership and who saw an opportunity for much plunder or many scalps might "enlist" if they chose. There could be no legal compulsion. Once they joined the war party they were under a loose sort of discipline, implied rather than laid down in any regulations. But a military office was not continuous. The leader's authority ceased abruptly once the campaign was over. He had no permanent title. The "general" this month might be the "buck private" serving under one of his former warriors next month.

The whole idea of an executive branch of civil government seems to have been foreign to the Indian concept of things. This is shown clearly in what was probably the most advanced Indian political establishment north of Mexico—that of the Six Nations of the Iroquois. It is, at least, the one about which the most is known. But, says Mr. J. N. B. Hewitt of the Bureau of Ethnology staff, who has made intensive studies of the Iroquois system, there was no man in the Six Nations entitled to be called "chief," or given any corresponding Indian title. There was nobody with legally constituted power to command in civil affairs and to punish disobedience of his commands.

Among the Muskhogean peoples of the Gulf States there existed what, at first glance, might seem to have been absolute monarchies. But analysis of these shows that they were not civil governments at all, in the accepted sense of the term. The status of the supposed rulers was that of high priests, or even actual gods. But they did

not exercise the functions of civil government. The same was probably true of such a man as Montezuma among the Aztecs. He was high priest, not emperor.

In actual practice among these southern Indians the line between spiritual and civil overlordship may have been very tenuous. But in theory they were not administrators of civil law. There were no executive offices in their governments.

Actually, Bureau of Ethnology specialists point out, the average Indian had very little freedom. The weight of tradition and tribal attitudes restrained his free behavior even more than laws restrained the behavior of the peoples of Europe. But there was no tribal policeman to attend to it. There was no need of any.

Above all, there was no hereditary transmission of civil or military authority. Every Indian stood on his own feet. The idea of hereditary rank was utterly foreign to the thought processes of the Indian. The beautiful Pocohontas may have been received in England as a princess, but in Virginia she was just another woman.

CURRENT BULLETIN BRIEFS

Manual for Foremanship Development. The importance of adequately trained supervisory forces in present-day industrial organizations cannot be too strongly stressed. This 60 page process-printed manual is based upon practical experience and is intended for both group leaders and the members of conference groups in industrial plants. *Industrial Relations Department, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.—$1.00 postpaid.*

Hammarlund Short Wave Manual. This revised edition of an already popular little booklet constitutes an authentic guide for the amateur and experimenter with high-frequency radio equipment. It comprises an introduction to the whole subject of short-wave transmission and reception, followed by many pages devoted to the actual construction of receivers. Thirty-two pages thoroughly illustrated. *Write for Bulletin 735A to Scientific American, 24 West 40th Street, New York City.—10 cents.*

Postal Telegraph and Cable Corporation Annual Report 1934. A résumé of the telegraph, cable, and radio systems of this organization, telling of the work accomplished in each phase. Pertinent financial information of particular interest to stockholders is also given. Of particular interest at this time are paragraphs concerning co-operation between the Federal Communications Commission and the Postal Company. *Postal Telegraph and Cable Corporation, 67 Broad Street, New York City.—Gratis.*

The Engineering Foundation Report for 1934. This 52-page booklet outlines the objectives and policies of the Engineering Foundation, now in its twenty-first year, and gives a summary of resources and activities. A report on current work fills several pages and is followed by a transcript of speeches given by such personages as Dr. Frank B. Jewett, Dr. Karl T. Compton, and others. *The Engineering Foundation, Engineering Societies Building, 29 West 39th Street, New York City.—Gratis.*

1935 Automobile Buyer's Guide. Anyone contemplating the purchase of a new automobile this year will be interested in this entirely new booklet which gives in popular language the inside story of many phases of automobile design and construction. Thoroughly illustrated with easy-to-understand drawings. *Write for Bulletin 735C to Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

Coal Preparation Book. Preparing coal of higher B.T.U. value at the lowest cost per ton by applying scientific washing methods is the theme of this new 32-page booklet. The Simon-Carves washing system is described in detail and thoroughly illustrated. One feature is the adaptation of the photo-electric cell to this work. *Write for Bulletin 735B to Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

For a Better Radio. Within the 12 pages of this thoroughly illustrated pamphlet will be found descriptions of many desirable units to be used in the construction of ultra-short wave, short wave, and broadcast receiving and transmitting sets. All of the units listed are of precision manufacture. *Write for Bulletin 735D to Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

Curing of Concrete Pavement Slabs. A report of a committee which has conducted a thorough investigation of the curing of concrete as used in pavements. Various types of curing processes were thoroughly tested and the results are given in tabular and graph form. Request Part Two, Proceedings of the Thirteenth Annual Meeting, Highway Research Board. *The National Research Council, Washington, D. C.—Gratis.*

Anhydrex Rubber Insulation for Wires and Cables is the title of a 16-page pamphlet devoted to an engineering discussion of a newly developed rubber insulation which is particularly applicable to electrical work where water or excessive moisture is encountered. Illustrated with several graphs. *Write for Bulletin 735E to Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

Stop Gullies—Save Your Farm, Farmer's Bulletin No. 1737, tells of the tremendous wastage occasioned by soil erosion and what the farmer can do to keep his soil where he wants it so that it will be of the greatest productive value to him. *Superintendent of Documents, Government Printing Office, Washington, D. C.—5 cents, coin.*

The Nickel Industry in 1934 is a survey of the entire field, covering distribution of nickel, its use in transportation and the heavy industries, as well as in other more generalized fields of usage. Prepared in printed form for quick and easy reference. *Write for Bulletin 735F to Scientific American, 24 West 40th Street, New York City.—3 cent stamp.*

Books SELECTED BY THE EDITORS

THE AIRCRAFT YEAR BOOK FOR 1935

WITH the sub-title of "The Only Official and Complete Record of American Aviation," this volume presents a complete picture of present-day aerial work including military and other government activities, the work of the transport lines and of private flyers, progress in such developments as blind flying, and so on, the status of airships and balloons, laws and regulations covering aviation, and a picture of the engineering and manufacturing side. The chapter entitled "Flying Facts and Figures" includes a series of tables giving information on all phases of aircraft, much too numerous to mention here.—$3.70 postpaid.—*A.P.P.*

ORTHOHYDROGEN, PARAHYDROGEN and HEAVY HYDROGEN

By Adalbert Farkas, Ph. D. (Frankfurt), Dr. Ing. (Vienna)

THIS is a translation of the first book about heavy water, originally written in German. It is not a popular or even a semi-popular book but is aimed at the well-instructed student of modern physics, who can handle mathematics. —$3.65 postpaid.—*A. G. I.*

PROGRESS OF ARCHEOLOGY

By Stanley Casson, M. A., F. A. S.

IN ten fascinating chapters the author, who is on the instructing staff at Oxford, takes his reader in turn to each of the centers of archeological excavation—Europe, Iraq, India, Asia Minor, Greece, Italy, Russia, Siberia, China, America, Africa, and the Far East and gives a general conspectus of what is going on in each place. His approach is popular and readable, and should provide a good taking-off point for further reading in archeology.—$2.15 postpaid. —*A. G. I.*

THE LIFE AND LETTERS OF SEBASTIAN ZIANI DE FERRANTI

By Gertrude Ziani De Ferranti and Richard Ince

THE name of Ferranti, while possibly better known abroad than in the United States, is nevertheless closely allied with the development of radio communication. After a man who has contributed largely to some phase of science has passed away, it is possible then and only then to publish a complete survey of his work and of his personality. Such a book is the present one. In 240 pages, well illustrated with half-tones, line drawings, and excerpts from letters written by Ferranti, this book gives a picture of the man and his work which will undoubtedly take its place as a valuable contribution to the literature of the development of radio.—$3.20 postpaid.—*A.P.P.*

SOS TO THE RESCUE

By Karl Baarslag

SAFETY at sea is an absorbing topic which is all too frequently brought to public attention by news reports of disasters. The author of the present book has, after a vast amount of research, prepared a running story of practically every major disaster at sea in which radio has played a part. A short summary of the history of CQD and SOS, well-known calls of distress, prefaces the inside stories of the radio operators' parts in such disasters as the *Republic, Titanic, Antinoe, Vestris, Morro Castle*, and others. In many cases, there appear here for the first time in print the actual facts of certain situations, not as learned by hearsay, but as told by radio men who stayed at their keys in the face of almost certain death.

This thrilling story of radio and its battle with the sea is all the more thrilling because it is true. No fiction or fancy garnishes the pages; here is only fact supported by adequate evidence. The book makes an excellent case for the service which radio has rendered to shipping, particularly in the figures given, which show the reduction in loss of ships at sea from 1900 up to the present day.—$2.70 postpaid.—*A.P.P.*

THE PRINCIPLES OF HEREDITY

By Laurence Snyder, Sc. D., Professor Zoology, Ohio State University

CLOSEST to our own ideal of a perfect popular scientific article was one on the determination of parentage by blood group tests ("Whose Baby," SCIENTIFIC AMERICAN, May 1934) by Professor Snyder, and now the same Professor Snyder has written a textbook of the science of heredity—that is, genetics. This is not an easy subject, though it has become an important one now that the science of heredity has become almost an exact science and is seen to have so much bearing on practical matters. As we might have anticipated, Professor Snyder has written an attractive treatise on this subject, surrounding the more solid parts of it with comment that is to the point, accurate, and withal readable, warm in tone, applicable to life outside the classroom, and the opposite of everything dull and stodgy. This book is also suitable for the student outside the classroom.—$3.20 postpaid.— *A. G. I.*

THE GEOGRAPHIC PATTERN OF MANKIND

By John E. Pomfret, Ph.D., Princeton University

A 408-PAGE illustrated study of the geographic influence of environment, in its bearings on the interpretation of economics, politics, history, and the other social sciences; in other words, a book designed to enlarge the background of those who maintain an interest in foreign affairs, read current history, and so on. It might be called a "human geography," since its emphasis is on the responses of human society to environment.—$4.20 postpaid.—*A. G. I.*

GETTING ALONG WITH PEOPLE

By Milton Wright

IF you ask the average person to name the attributes of success, most likely he would talk vaguely of ability, education, and even pull; and would tell you that personality has much to do with success, without being able to tell you just what personality is. The title of this volume seems to us the best key for unlocking the doors of individual progress. To get along with people, as this author shows, does not mean necessarily that you must have a bright and witty personality, a thorough acquaintance with a five-foot shelf of books, or the formula of a go-getter salesman. Mr. Wright shows in carefully worked out detail how a man may find the greatest happiness, and success according to his ambitions, by learning how to understand people. To us this proved a most interesting psychologi-

cal study of the problem which faces many people today but we were particularly interested in the chapters entitled "Adjusting Yourself to the Other Fellow," "Attracting Attention," and "Establishing Right Relations." Other chapters such as "The Power in Suggestion," "How to Say No," and "That Inferiority Complex" also contain considerable food for thought.

We can see a real need for this book and we predict that it will enjoy a large sale.—$2.65 postpaid.- *F.D.M.*

THE FRUSTRATION OF SCIENCE

By Eight Men of Science

A SMALL book of separate chapters which show how mankind has been unable to make full use of the possibilities of science, while its destructive possibilities are developing too rapidly. --$2.15 postpaid.—*A. G. I.*

THE STORY OF DIAMONDS

By A. C. Austin, Geol. E. and Marion Mercer, E. M.

TWO graduates of the Colorado School of Mines wrote this little book, and it is not only an accurate piece of scientific writing but an excellent piece of reading. It explains the nature of diamonds, their occurrence and geology, their mining and their cutting, also their uses in industry. It describes and illustrates the world's famous big diamonds. We have seldom seen a happier concatenation of authentic statement and thoroughly fascinating reading than this 90 page. well illustrated book.—60c postpaid.- -*A.G.I.*

TUBERCULOSIS, A BOOK FOR THE PATIENT

By Fred G. Holmes, M.D.

THE Chief of Staff of the Good Samaritan Hospital at Phoenix, Arizona, who is also Director of the National Tuberculosis Association, sets down in this book for the layman information about tuberculosis, its symptoms, the choice of a physician, planning and conducting the treatment, air and sun baths, modern treatments—just the facts which a person who may be tubercular, or think he is, should possess in order to make the next move intelligently. He goes into considerable detail, but this is by no means a self-treatment book.—$2.20 postpaid.— *A. G. I.*

FISHES AND THEIR WAYS OF LIFE

By Louis Roule, Professor at the National Museum of Natural History of Paris

"THE living world of the waters" is here shown in all its amazing diversity. While ostensibly prepared as a popular book, the present volume smacks more of a classroom text although it might be said to be a compromise between a heavy, scientific treatise and a popularized version. Anyone interested in the science of ichthyology will find this book fairly easy reading and highly informative. Fishermen who take their sport seriously will find much of value in these pages. Many line drawings of various types of fishes illustrate the text. Over 300 pages with a fairly comprehensive index. The Scientific Book Club selection for June.—$3.95 postpaid.—*A. P. P.*

MEN AND SHIPS OF STEEL

By Wayne Francis Palmer and Hanson W. Baldwin

SOMETHING like 200,000 photographs were studied by the authors to pick the 275 that were finally used. Their efforts have resulted in the production of a classic. As a history and description of the U. S. Navy from the days of sailor's pig-tails and bushy whiskers to the present-day big guns, airplanes, submarines, and so on, this book is a masterful job. And why not, since both collaborators are former Navy men and know intimately the traditions of the Navy? In this salty "poem in pictures" they express for lovers of the sea a fine feeling for that arm of American national defense of which we are justly proud.

This volume is recommended without reservation to those of our readers who frequently ask us for sources of Navy pictures.--$3.75 postpaid. -*F. D. M.*

WHAT MAKES PEOPLE BUY

By Donald A. Laird

THE professor of industrial and applied psychology at Colgate University now prepares a readable treatise for sales managers, advertising and business men. This book is a study of what the customer is like, what he wants, what are on the top layers of his mind, and what a successful salesman is like. This is a practical book for practical people and is not a thesis for closet students. It is based on the newer findings in psychology.—$2.65 postpaid.—*A. G. I.*

TOOLS OF TOMORROW

By Jonathan Norton Leonard

TECHNOCRACY about two years ago threw a scare into us. The glib statements of self-styled experts created much excitement and many people began to fear for the future of the machine age. Tools of Tomorrow discusses the same general theme but from a saner foundation of fact. In this extremely interesting volume we find but little of the sort of pessimism which motivated the technocrats; the only pessimism expressed by Mr. Leonard is in respect to man's intelligence in using the tremendous forces which he has unleashed through scientific research. "Tools of Tomorrow" gives facts and figures to show that we have available everything we need from fuels and natural resources to the knowledge of how to harness them in the creation of a greater progress for the future. He discusses applied science in all its forms in such a way as to grip the reader's imagination and create a feeling of optimism for the future.—$3.20 postpaid.—*F.D.M.*

THE CHANGING WORLD OF THE ICE AGE

By R. A. Daly, Professor Geology, Harvard University

A VERY compact book, full of sum and substance, regarding the ice drama of thousands of years ago, and written by a noted geophysicist. It brings together existing scientific knowledge, particularly about the changes of sea level caused by subtraction of water from the oceans to make great ice caps, also changes of land level, some of them complex, due to down-warpings and up-warpings, past and present, of the earth's crust because of the ice load on it. It also states the connection between these glacially caused sea-level changes and the growth of coral reefs. The amount of data presented is so great and so compact--certainly there is no padding--that if one were to try to mark the important parts he would have to mark most of the book.—$5.20 postpaid.—*A. G. I.*

WISH AND WISDOM

By Joseph Jastrow

IN this 389-page book a noted psychologist brings together 28 separate accounts which center about human credulity, and the kind of wishful thinking indulged in by about half of the living specimens of homo sap. For example: Conan Doyle's fairies; Madame Blavatsky's cult; ouija boards; psychic adventures; Patience Worth; numerology; phrenology; "N-rays"; auras; vibrations; ectoplasm. The treatment of these and other erratic episodes in human gullibility is quite dramatic, the form being mainly narrative. Good reading.—$3.70 postpaid.—*A. G. I.*

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

CONTENTS · AUGUST · 1935

The SCIENTIFIC AMERICAN DIGEST

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ACROSS THE EDITOR'S DESK

"THE long dispute over the nature of cosmic rays is perhaps at last coming to a conclusion. The study of this penetrating radiation from outer space has for years been a battlefield on which two opposing schools of thought struggled for supremacy. Dr. Robert A. Millikan of the California Institute of Technology was the leader of the older school, which maintained that the rays were made up of photons or light quanta. The exponents of the newer theory, led by Dr. Arthur Holly Compton of the University of Chicago, are diametrically opposed to this view. They believe that the rays are streams of electrically charged particles, including positive and negative electrons, with possibly some protons and alpha particles." Thus is introduced an article entitled "The Cosmic Ray Puzzle," by Jean Harrington, scheduled for publication next month. Miss Harrington goes on to describe the dispute and its various ramifications and concludes as follows: "But cosmic rays may not remain a mystery for long. Science is busy, finding and fitting together pieces of the puzzle, making clear, bit by bit, its intricate design, and approaching gradually the completion of the picture."

●

PURSUING still further the subject of modern housing, Philip H. Smith, author of the article "Ready-Made Houses" which starts on page 66 of this issue, will present next month a story of modern materials and how they have radically changed home construction. The developments of science are constantly reacting to the benefit of the average man, and in no phase of existence is this more true than in the construction of homes.

●

WHENEVER engineers set out to conquer some phase of nature, problems are always sure to arise which call for new and unusual solutions. Thus, while a bridge may be considered merely as a bridge, the actual construction of it almost invariably involves some new method of getting around seemingly insurmountable obstacles. A bridge recently completed and opened to traffic in Denmark is no exception. This structure, for combined railway and highway use, spans a deep and rapidly flowing link to the sea which separates the peninsula of Jutland from the Island of Fünen. This bridge, aside from its unusual structural features, has an important economic significance. It will greatly speed up transportation, replacing as it does a ferry service which has been continuously active since 1872. While in favorable weather the ferries were able to make the run in about 15 minutes, fog and snow frequently upset train schedules and caused serious delays. The story of the construction of this Danish bridge will be told by R. G. Skerrett in an article scheduled for publication next month.

COMING

- "The Cosmic Ray Puzzle," by Jean Harrington
- R. G. Skerrett, on the Construction of an Unusual Bridge in Denmark
- "In Defense of Insects," by Albert Dickman, Ph.D.
- A Two-Page Drawing of the Dewey Class of Destroyers
- Philip H. Smith on the Materials Used in Modern Houses
- The Significance of Aviation Records, by Reginald M. Cleveland

●

WITH moths and beetles attacking clothing, furniture, and stored foods, several varieties of insects destroying food crops to the extent of millions of dollars annually, houseflies spreading disease, and other insects doing untold damage in various fields, it is small wonder that insects as a group are roundly condemned by many people. When, however, you read the article entitled "In Defense of Insects," by Albert Dickman, Ph.D., to be published soon, you will find that the denunciation of insects cannot be carried very far. Man's convicted enemies in the insect world amount to only about 300 species. When we realize that over 500,000 species of insects have been classified, with thousands more awaiting classification, it becomes apparent that we cannot condemn the whole class for a small number of disreputable members. Dr. Dickman cites many interesting examples of the beneficial work of insects and points out that many of them are absolutely essential to human welfare. Although after reading this article you will still continue to spray insecticides, you will have gained a greater appreciation of how some insects contribute to your daily welfare.

●

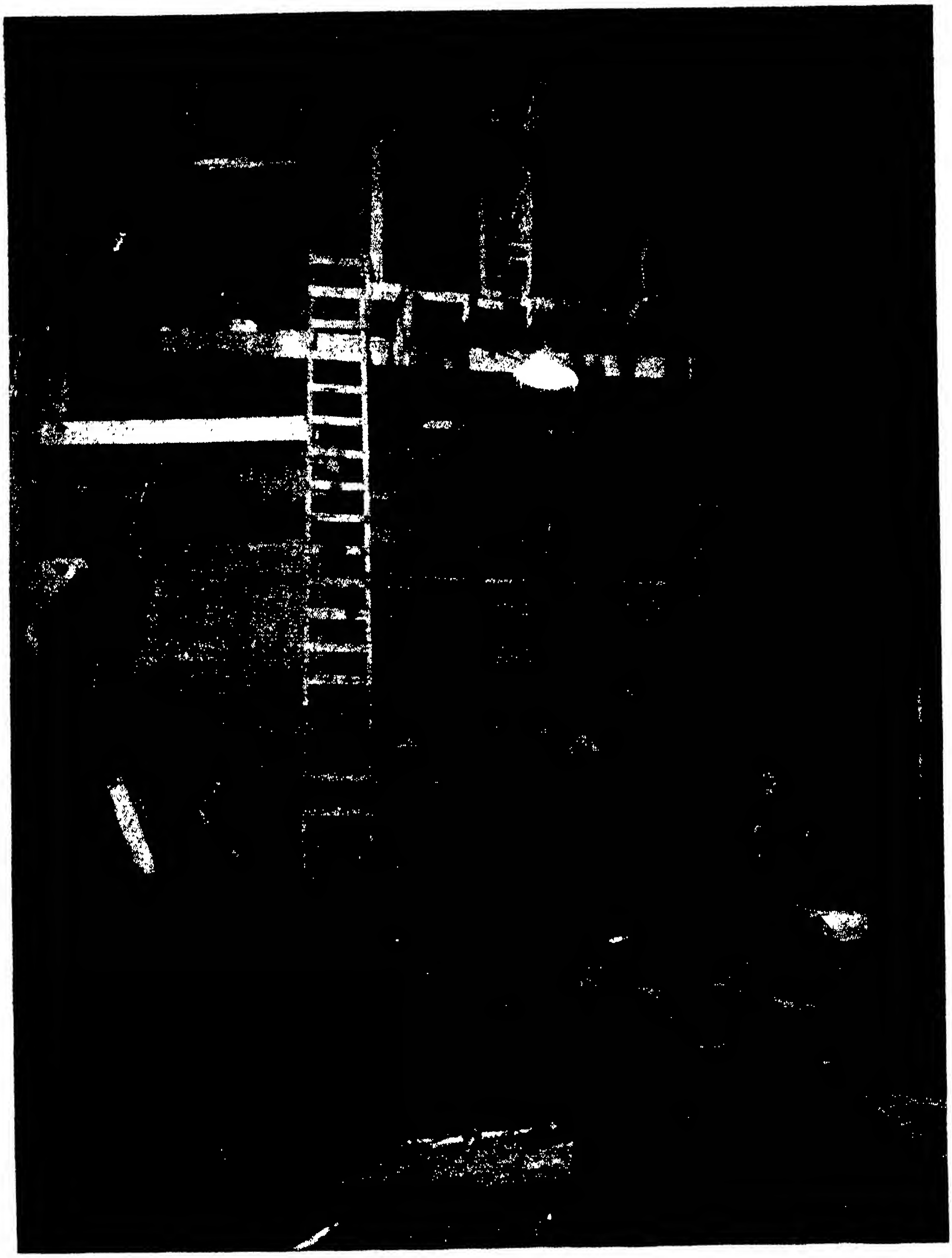
NEXT month we will present a double page illustration, drawn especially for SCIENTIFIC AMERICAN, showing the details of the Dewey class of destroyers. This new type of vessel, the first designed by the United States Navy since 1921, is also the first of its class equipped to combat airplanes effectively. The destroyers each mount five five-inch guns of the so-called "mystery" type which was so designed as to permit a range of fire from the horizontal to the vertical. These new destroyers are reputed to have a speed of from 32 to 35 knots although in some quarters the top speed is said to exceed these figures. An additional feature of vessels of the Dewey class is that particular attention has been paid to the design of living quarters for the crew, giving the men all comforts possible on a vessel of small size. The drawing which we will publish is exceedingly attractive and undoubtedly many readers will wish to preserve it for future reference. It will be so printed on two facing pages that it can be removed from the magazine and framed for display.

●

WHEN the newspapers announce that a new record has been set by an airplane for altitude, distance, economy of operation, or some other phase of flight, the general reaction is all too frequently: "What of it?" In an article to be published soon, Reginald M. Cleveland, well known to our readers for his articles on aviation, will tell of the significance of these air records, why they are so eagerly fought for and what they mean to the aviation industry in general.

Orson D. Munn

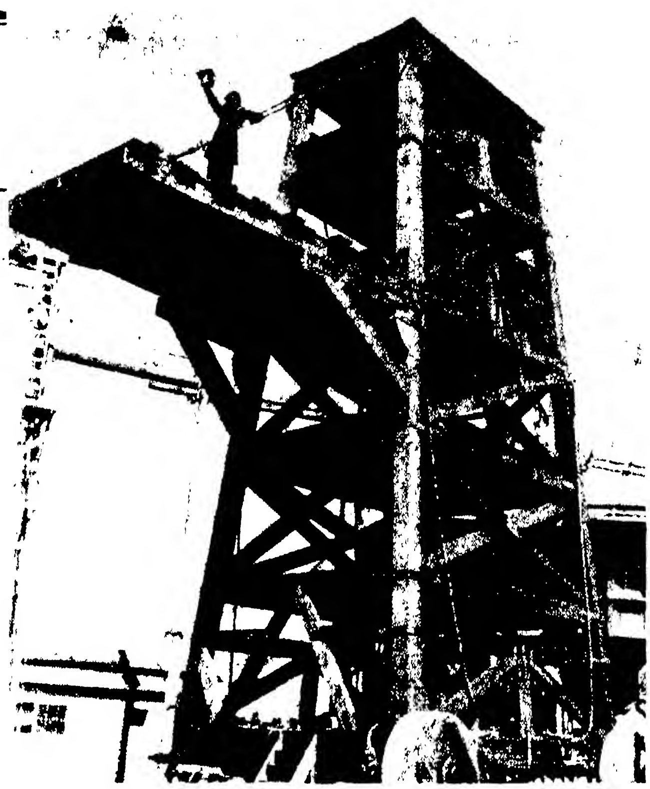
Editor and Publisher



TEN FEET OF CONCRETE PROTECT TUNNEL WORKMEN

THIS 10-foot-thick concrete bulkhead in the new Midtown Hudson Tunnel, New York, holds air pressure in a compressed-air section of the tunnel where men are working. Through this wall pass a material-lock (center), a man-lock (right), and an emergency-lock (top). These locks permit exit from the tunnel to the outer air, pressure being equalized in them. The man at the left is operating an electric hoist used to pull work cars. A short section of track at the material-lock door is removable so that the door may be closed after a loaded car has entered the lock chamber in the concrete bulkhead.

Standing 50 feet high and weighing 15 tons, this siege tower—replica of the great war machine employed by the Crusaders at the battle of Acre—is one of the largest movie "properties" ever constructed in a Hollywood studio



ANCIENT BATTLES IN THE MOVIES

Catapults . . . Battering Rams . . . "Tanks" . . . Armor . . . Swords . . . Shields . . . Historical Accuracy Assured By Research . . . Tricks Used

By ANDREW R. BOONE

TWO hundred Crusaders stood at ease before the wall of Acre. Scores of Saracens looked down on the cameras from the high parapet. Nearby stood a gigantic siege tower, while from a position midway between its two forward columns protruded a battering ram swinging lazily from heavy chains. At one side an 11-ton wooden catapult, capable of tossing a huge rock over the 50-foot wall, was ready to aid in the assault.

Two-score cross-bowmen in dulled medieval armor stood behind wooden mantlets—large wooden shields on wheels, replicas of the first "tanks" ever to appear in battle—awaiting orders from the director, who now addressed them.

"Mantlets will advance to the moat," boomed the loudspeakers. "There you cross-bowmen will cover the advance of the siege tower. Bowmen on the tower direct your arrows at defenders on the wall. The catapult will lay a heavy barrage. Foot soldiers shove the siege tower into place. You men on the wall—return the attack of arrows. Resist the besiegers. Roll rocks and timbers from the wall.

"Everybody ready for the battle? Okay. Roll 'em."

Under the brilliant lights flooding an outdoor set on a Hollywood movie lot began the historic siege of Acre—fought 748 years ago, long before the advent of fire-arms.

JUST as the Christian horde assailed the walls of Acre, less than 100 miles from Jerusalem, these play-soldiers of Hollywood moved the creaking tower forward. The long wooden arm of the stone-caster shot upward to deliver its lethal load among the defenders, but to a point where the missiles would land without harm to actors. Long bows and cross-bows snapped forth their short arrows. Slowly the huge siege tower, 15 tons of timbers standing 50 feet high on iron-rimmed wooden wheels weighing a ton apiece, rumbled forward.

Shouts of attackers and besieged filled the air. Actors in medieval mail, some wearing heavy metal helmets, grouped about the machines of war. Dust settled over the scene. Swordsmen armed with gleaming blades, long metal shields on their arms, walked along the advancing lines, urging the men on. Here was a page from ancient history, coming to life for the screen!

Thousands of properties, from chain mail to the siege tower, make the filming of historic spectacles possible. For nine months before the camera filmed the first scene of "The Crusades," story of Christendom's two-century movement against Islam, Cecil B. De Mille searched famous museums for descriptions and sketches of instruments of war, armor, costumes, and customs—everything that would contribute to the accuracy of the picture.

He found data on the largest siege tower ever built—and reconstructed it, complete with battering ram, which bore the likeness of a ram's head.

He found sketches of the powerful catapults; secrets of ancient Greek fire, forerunner of modern flame-throwing and poison gas; mantlets which, in a crude yet effective way, were the first "tanks"; trenches and tunnels, where trench warfare was waged; incendiary bombs; deadly battle pikes, with which a foot soldier could pierce the armor of a cavalryman, pull him from his horse, or crush his head. All these highly effective weapons and war developments were in use before the Dark Ages had passed into history.

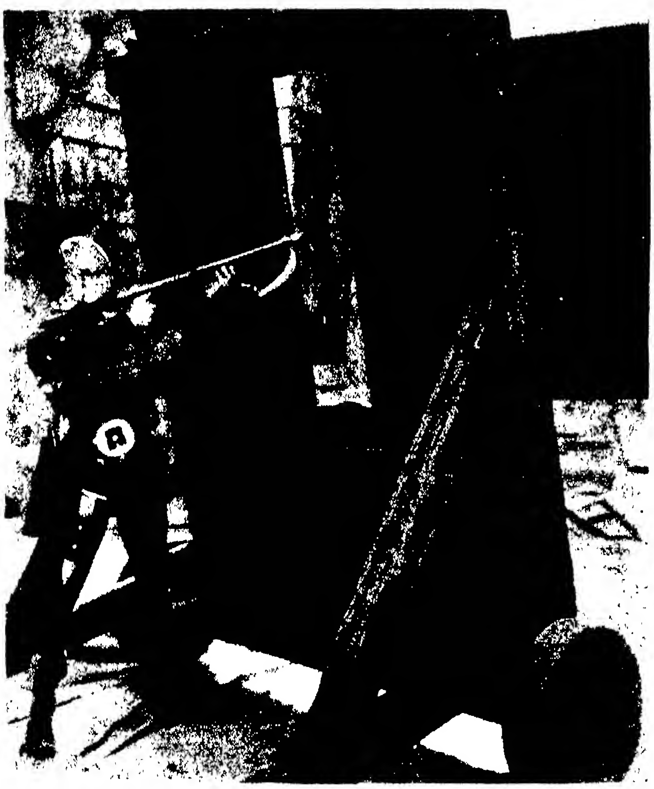
The siege tower which I saw advance to the wall of Acre was square, tapering to the top, and included five decks, connected by ladders. Open at sides and rear, the upper front was protected by a drawbridge, lashed tightly to the tim-

bers until it reached the moat. Wet skins covered the lower part, giving protection against fire and arrows.

Each deck served a particular purpose. From the top platform archers poured a barrage of arrows into the defenders of the town. Soldiers on the fourth level lowered the drawbridge across the moat and onto the wall. On lower floors were massed dozens of soldiers, ready to ascend and cross the drawbridge. On the lowest platform husky warriors manned the battering ram, ready to crush the strongest masonry.

Only one tower was used in the movie assault, though three had been employed in the siege of Acre. During a lull in activities, while perspiring actors rested from their arduous work, De Mille told me an illuminating story about them.

"During the siege," the director explained, "the defenders of the city threw clay bombs onto the towers. These burst on impact, but since the crusaders suffered no harm they became amused. After many bombs had been thrown, flaming torches were cast about. Two towers and all the men on them were consumed by flames. Little did they realize the towers had been soaked by an inflammable liquid contained in the bombs."



A movie cross-bowman of the Crusaders' legions is protected by a wooden mantlet, first "tank" ever to be used in battle

The horrors of flame as a weapon were known to the Arabs and Byzantines as early as the 7th Century, but not until the Christians poured into Eastern Europe and Asia nearly four centuries later did the Crusaders face fire on the battlefield and in the trenches. And so in a corner of a metal-walled shop I saw an expert in chemistry and fire reproducing with benzine, sulfur, carbon, nitre, and cotton waste the flaming oil torches and liquid flame which brought terror to ancient fighting men.

It was with such weapons the first trench raiders were repulsed. As I stood in a trench at the foot of Acre's wall, Harold Lamb, technical expert, told me how the Normans started to tunnel under the wall of a Byzantine city, and the defenders dug a counter-tunnel at right angles to the approach. Sentries stationed along the counter-tunnel sent a detachment of flame throwers to the threatened point where they heard digging. They opened up a small hole and thrust in flame projectors, spraying the enemy diggers with fire from pine resin and sulfur. Thus was trench warfare, born underground seven centuries ago, recreated in a battle of make-believe.

Although of short range as compared with modern artillery, the catapult sounded and looked like a deadly weapon as the mimic battle raged. It was, in reality, a great cross-bow having the power of thousands of its little brothers.

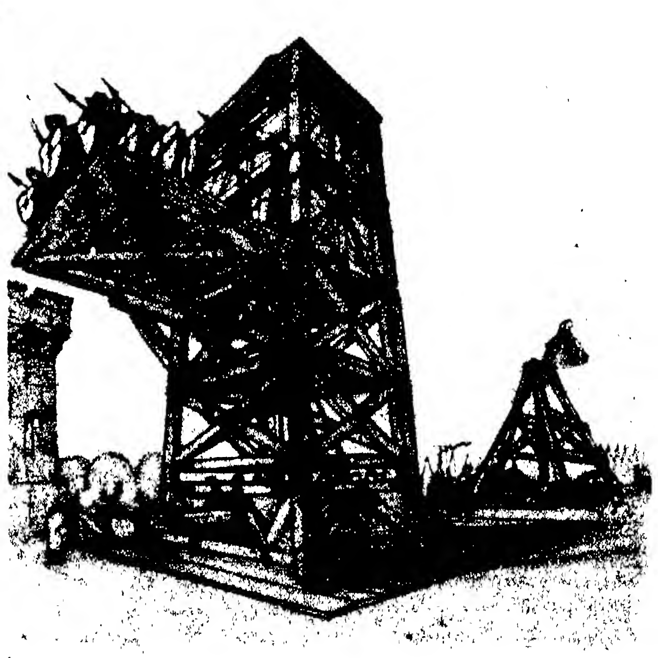
The long arm, fitted with a bucket-like container at the outer end, was pulled down to a horizontal position, until the steel-stripped plywood layers of the bow seemed ready to split. Soldiers charged the weapon by placing a rock in the iron cradle. On signal, they released the trigger, and the bent bow fixed to the head frame snapped the arm forward and upward with a thud which threatened to pull the machine to pieces, casting its heavy charge forward in a graceful arc.

As the assault on the tower went forward amid the thud of the battering ram and the clashing of swords, the sounds of steel striking steel reaching me above the shouts of the combined forces below were very realistic.

SWORDS and shields, I learned, were in fact made of tempered steel, while men's helmets were pounded out of brass or, in the case of combatants, constructed from 16-gage iron, for the microphone soon revealed that only iron gave out the true sound of metal on metal when an aluminum battle mace cracked down on a helmeted head. Whenever a noble sank to his knees from a head blow, often of sufficient force to crack his skull, a football helmet saved him from injury, while a paper container of red blood-like liquid, smashed by the impact, poured down over his face.

As bowmen discharged their shafts from the walls of Acre or attacked defenders from the topmost platform of the powerful siege tower, real arrows, metal tipped, plunged into breasts with the force of bullets—not the rubber-tipped arrows shown leaving the bows wielded by extras, but shafts flying from other bows in the hands of expert archers who aimed them straight at the breast. Arrows flew true, struck, quivered. But they harmed no man, for each actor struck down by an arrow wore a breast shield of cotton cloth and metal.

Movie soldiers could not wear the



Drawing of siege tower (see preceding page) and catapult, from which architects designed the machines used in the film battle

gleaming armor boasted by the crusading knights. Highly polished steel and brass reflected too many rays from lights and the sun. Paraffin and rubber paint killed the glow. Modern knitted aluminum mail replaced the steel mesh of old, both because of cost and weight. To give it just the right touch of antiquity, workmen painted the chain mail with silver lacquer and flattened it between machine rollers.

In order to accustom the horses to the additional weight as well as to these strange costumes, actors rode their mounts daily for six weeks before appearing in the first scene. They rode at first in customary riding clothes. After a few days they changed saddles, using now high-backed saddles of double weight which provided a needed back rest when thrusting lances.

An 11-ton catapult made for the movies. The great crossbow, built of plywood and steel, can throw a one-ton rock over a high wall. See the text

Workman making the trick sword which severed a silken scarf by burning through it

One by one the various pieces were added to the equipment—a shield on the left arm, then a sword, next the face piece on the horse, now a lance set in its special stirrup—until at last each horse carried an extra hundred pounds, and actors were galloping around the hills of Hollywood in full armor.

For nearly a year before the cameras filmed the first scene, technical experts prepared weapons, armor, decorations for warriors and horses—everything that might bear on the Crusades. Workmen in New York and Hollywood forged swords of tempered steel, cast battle maces of aluminum, pounded out iron helmets. Jewelers created thousands of make-believe pearls, some large as oysters, and fashioned semi-precious stones into glittering crown ornaments.

Thousands of lances, battle maces, pikes, swords, neck and face shields for horses, metal-clad blankets, chain mail for knights, shields for shoulders, arms, hands, chins, and knees for riders and cross-bowmen—each was made after the manner of its counterpart worn seven centuries ago, many offering more actual protection than those worn during the Crusades.

NOT only the incidents portrayed in an historical picture but also all properties and sets must be true to recorded accounts, else some who view the completed play, in the United States or abroad, will challenge its authenticity. Novel methods are employed to recreate some of these episodes and scenes.

Long before the large Acre set was created, artists created sketches from reproductions found in historic works. After several sketches were made, complete in detail, draftsmen made drawings, showing all parts accurately.

To build high, thick walls of solid stone not only would prove too costly, but the producer could not afford to waste valuable time for striking and rebuilding the set. Accordingly he had skilled workers take plaster moulds of rocks forming the breakwater which extends two miles into the sea at the entrance to Los Angeles harbor. A few days later rocks cast in plaster rose to form the protecting wall of Acre, while painters, working with blow torches, paint, and oil stain "antiqued" wooden towers and the larger tools of war.

Finally, De Mille desired to film the storied scene wherein King Richard and Saladin the Infidel were bragging over the merits of their respective swords. Richard cut through a heavy iron mace with his sword. Saladin replied by tossing a silk scarf into the air and cleaving it in two. This Richard could not do, for his iron blade was no match for the razor-sharp Damascus steel wielded by Saladin.

How Saladin should cut the scarf for the picture was the problem. No sword could be found in Hollywood that would do the trick. A workman in the studio's machine shop solved the problem. He cut two flat pieces of wood fibre and curved them to resemble a sword. Along the thickened back edge he fitted a length of copper wire. Over the two pieces of fibre, pressed tightly together, he fitted a length of asbestos tubing. Next, he painted the asbestos with retort cement, which will withstand a heat of 2500 degrees, Fahrenheit, before breaking down. Finally, he ran a resistance wire along the cutting edge. In a matter of seconds the resistance wire reached a white heat when electricity was applied, and the actor, rather than cutting the scarf, literally burned a path through the cloth.

Thus do the movies strive for accuracy in portraying historical scenes. When "tricks" are employed, the reason is usually to expedite the filming operations, or, frequently, because the "trick" shot will appear more real than reality itself.

DIGGERS IN THE FIELD

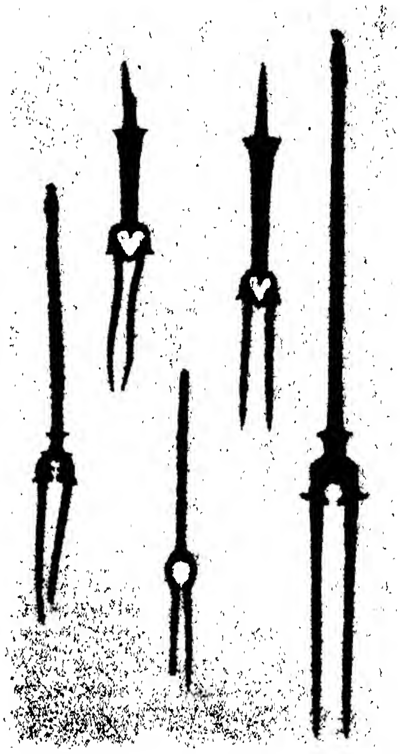
Archeologists Dig Up Ancient Utensils Very Much Like Our Own . . . One of Them a Mystery

By ALBERT G. INGALLS

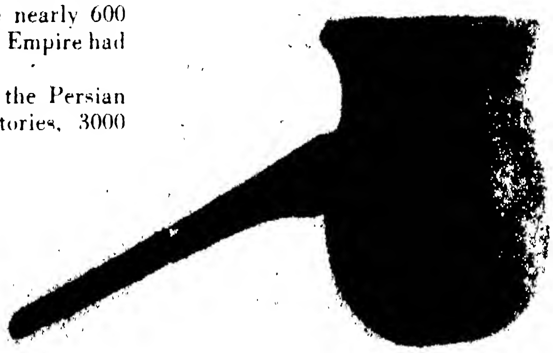
THE artifacts shown on this page were found near Shiraz, in Persia, by an expedition of the Metropolitan Museum of Art, New York, which dug on the slope of a hill once occupied by a fortress and a town, and uncovered pottery, gold jewelry, glass dolls, bronze candlesticks, and other objects of archeological interest. They are from the Sassanian period of Persian history, which dates from 226 A.D. to the conquest of Persia by the Saracens in 644 A.D. Thus they do not pertain to the earlier Persian period made most famous by military exploits—the one which is generally meant by "the" Persian Empire—but to a less widely known Second Persian Empire, or New Persia, a revival which took place nearly 600 years after the First Persian Empire had been wiped out.

Most readers will recall the Persian Empire of the school histories, 3000 miles long and 1000 miles broad (the size of the United States), which was peopled with racial stock closely related to the Caucasian stock of modern Europe, often miscalled Aryan. That empire rose in 539 B.C. under Cyrus. The story of its attempts 50 years later to overwhelm Greece at Marathon and elsewhere is familiar to all. Some 200 years still later, however, that same empire was itself overwhelmed and abruptly ended by Alexander the Great.

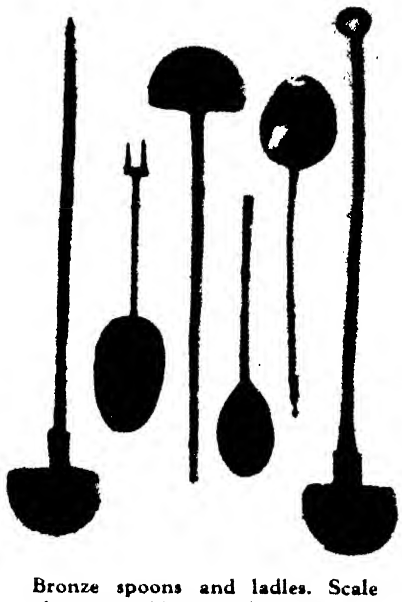
Then came centuries of Roman greatness—though Persia did not fall to Rome but to the neighboring Parthians and stayed out of the picture for six whole centuries. But in 226 A.D. Persia had a new inning under a patriotic Persian family, the Sassanians, who threw off the Parthian yoke and brought their country to a brilliant comeback which actually lasted longer than the first empire. Though it was a smaller empire it was a more enlightened one, and Rome, by that time falling to pieces, was willing and glad to ape the customs of the New Persia. (In Rome the state had recently become hitlerized and the people, living on the dole, had lost their sense of public responsibility. Taxes to support the dole crushed them. They soon lost their freedom. These lessons of history are readily available today.)



Bronze or copper forks. Some of these were perhaps for serving



The "eye-dropper" object whose real purpose remains undetermined



Bronze spoons and ladles. Scale about 1:3. Note combination tool

The objects shown in the accompanying photographs pertain to this brilliant New Persian period of history—the one which decadent Rome was glad to ape—and they practically explain themselves. Forks, spoons, ladles, and so on, were not then dissimilar from those we use in 1935. The forks perhaps look odd to us but they would not have looked odd to our own great-grandfathers, since four-tined forks are a comparatively recent innovation.

THE peculiar object in the center picture was called, for lack of a better term, an "eye-dropper" by the archeologists in the field, but its real purpose remains unexplained. In some ways it resembles something in common use comparatively recently but as fully forgotten in 1935 as flint and tinder, Model T Fords, or the art of bundling: that is, the "pap boats" or baby feeding vessels used until a century ago for stuffing our infant great-great-grandparents with pap. Breadcrumbs boiled in water, often served in wine or beer from a vessel having a spout for the baby's mouth—that was pap. Some have suggested that the unidentified object might have been a pipe for smoking. They forget that tobacco was a New World plant not yet discovered. The whole Persian, as well as the Roman and other empires of antiquity, rose, flourished, and declined without a single citizen thereof enjoying a smoke.

If the object in question was not a pap pot, and was not a pipe, what was it? Perhaps some of our readers can suggest what it was.

OUR POINT OF VIEW

Youthful Engineers

THE problem of guiding the youthful student in his choice of engineering as a profession has long harried the minds of educators and has puzzled parents; the lack of adequate guidance has left the student bewildered. Often high-school boys have turned to us for information to help them make the fateful decision, yet we could help but little in giving such long-distance advice; it must be understood that only those close to the student can best evaluate his strictly personal aptitudes and abilities.

Into this problem the engineering profession has long put a great deal of study and has finally evolved a nation-wide system of student guidance, according to an announcement by the Engineering Foundation. Direct contact will be established with students, parents, and teachers through local engineering groups to provide continual counsel for boys who plan to adopt engineering as a career. Dean R. L. Sackett of Pennsylvania State College has been appointed Chairman of the committee on student selection and guidance which will shape the new educational activity. The task of this committee will be to discover the engineering type of mind and to interpret engineering as "a career and as a culture." Local units of the participating engineering societies will be called upon to form in each locality a sympathetic, understanding committee, and engineering schools everywhere are being asked to co-operate.

It is the intent of this new program to give much-needed occupational information to the high-school and prep-school student so that he may understand the demands made on him in preparing for various fields of usefulness, the nature of the service performed and the character of the opportunities afforded. Engineering will be presented in a broad sense with more emphasis upon its functional aspects than upon its technical sub-divisions. That is, such activities as construction, design, operation, management, service, sales, analysis, research, development, production, evaluation will form the real basis of the boys' consideration for or against the engineering profession.

We believe that this plan for student guidance, backed as it is by the Engineering Foundation and member societies and carried forward by some of the ablest educators of the country, is a workable and most promising one for the future. There is one point, however, which was not stressed in the original announcement and which is highly important. This is the question of difficulties that lie ahead for the youthful student. We have seen cases in the past where youngsters have had painted for them glowing pictures of the opportunities in engineering only to find after getting a degree that personal aptitudes were not taken fully into consideration. It therefore seems to us that the study of students' aptitudes is the primary key to the whole problem and it is to be hoped that the Engineering Foundation, in developing their nation-wide program, will observe this fact carefully and devote to it considerable study.

Pan-American Business

WHILE many nations, including ourselves, have been frantically endeavoring to assure outlets for their products through reciprocal trade agreements—horse trading, as it were—a movement of surprising, and gratifying, magnitude has been quietly taking place in Pan-America. The "Colossus of the North," as the United States has often been called with unkind intent, seems to be recapturing the South American market with a vengeance. In 1934, while our imports from that continent increased 13 percent, our sales to South America increased over 41 percent. The result was that we took the lead as an exporter to these markets, displacing Great Britain who showed a gain in 1934 of only 12 percent.

Our gains as compared with world gains, as a whole, are typified by the following examples, *in percentages:*

	Total Imports Gain	Gain in Imports from U. S.
Argentina	5.5	23.
Uruguay	1.5	70.
Ecuador	73.	113.
Chile	33.	70.

To many people, this showing is a portent not only of world recovery but also of future more friendly relations between ourselves and our southern neighbors. Too often have they distrusted our motives, called us grasping, imperialistic. We should like to disabuse their minds of such ideas. An increasing trade between us will help, for it will necessitate a wider contact of representatives, trade commissions, and the like. It will not work miracles, however. Even before the depression, the United States was the leading exporter to South America. And it might be said that some countries will buy regardless of personal feelings simply for economic or quality reasons.

Nevertheless, there is now an entirely new outlook. We have evacuated Nicaragua and Haiti—for the occupation of which we have been so bitterly assailed—and our present "hands-off" doctrine in pan-American politics should inspire greater confidence in us among our southern friends. We hope the time will come when they will look upon us as a big brother whose highest aim is to build up and maintain a feeling of good will in this hemisphere. Ay, 'tis a consummation devoutly to be wished!

Anglo-American

SPEAKING of international relations: Many Americans were pleased with the recent remarks of Mr. Stanley Baldwin and Captain Anthony Eden anent the desirability of closer co-operation between Britain and the United States. It *is* an interesting proposal, but before committing ourselves, we will await development of concrete plans.

False Prophets

EXPOUNDERS of false doctrines are abroad in the land. They seek to gain political profit or power over the masses, or both, by deluding an already befuddled public with half-truths, by citing distorted figures, and by sowing the seed of class-hatred. Lest, therefore, we fall too surely under the influence of one modern Mesmer of the radio who claims that prior to 1930 there had been a steady, devastating decrease in employment and in wages, let's look at some figures.

From the post-war boom year 1920 to the year 1930 (after the crash), the number of American workmen gainfully employed rose from 41,614,288 to 48,829,920—*U. S. Census.* The index number of real wages paid to industrial laborers was 112.2 in 1920 and 136.4 in 1929—*U. S. Bureau of Labor Statistics.* Total volume of wages paid was 29,540,000,000 dollars in 1920 and 34,485,000,000 dollars in 1929—*Brookings Institution, Washington.*

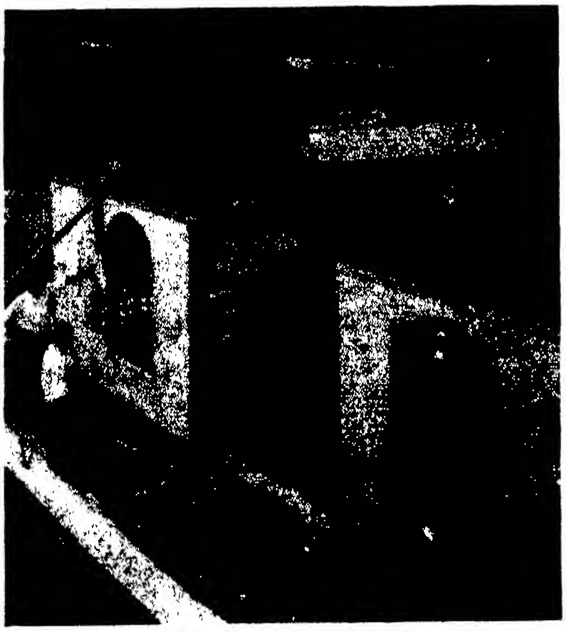
There seems no way of stopping the false prophets who maltreat the truth of these figures via the air waves, so we suggest turning the dial to the program of some clown who makes no pretense of seriousness.

Ready-Made Houses

Houses from Catalogs . . . Pre-Fabricated Steel . . . Pre-Cast Concrete . . . Several Types . . . More than Mere Novelty . . . Basic Accomplishments

By PHILIP H. SMITH

IT may sound like fiction, but you can acquire a full-size, life-long home simply by ordering from a catalog and telling the dealer where to erect it. When you take possession a month later, the refrigerator will be making ice cubes; the heating plant will be throwing cool, conditioned air through the rooms; and, as likely as not, the radio will be playing. All you have to supply is something to sit on, something to sleep on, and whatever other furniture you think necessary.



With the foundations in, it is a simple job to set up the pre-cast concrete slabs here shown, that are made according to a new process with imbedded window and door frames. The completed house is shown at right

This is the pre-fabricated house about which you have been hearing from coast to coast. Several types are on the market, all essentially the same in being more or less complete, factory-made products, modern in thought, construction technique, and execution. They symbolize the combined genius of manufacturer, architect, chemist, construction expert, and, of course, the visionary.

All the noise and bustle stems from the work of some 50 pre-fabricators, less than a dozen of whom have actually sold a house. Small wonder then that the public knows not where pre-fabrication stands, whether it is a novelty, running on momentum gained at the Century of Progress and local exhibitions, or is the agent of a new era typified by a house on every lot.

Make no mistake—there is more in pre-fabrication than mere novelty. How much more is hard to discern until sponsor's aims are known, until methods are analyzed, and the basic accomplishment reviewed.

The building fraternity is unanimous in declaring that a restricted buying power is an obstacle athwart the path of home building. The more conservative believe it will revive when economic forces conspire to increase buying power, while the more aggressive and radical elements in the profession hold that the stimulus to building must be given by the industry itself through reduction of costs. Among this latter group are the proponents of pre-fabrication. This is an overly simple statement which should be qualified by noting that there are many progressives who feel that high land values, taxes, and realty speculation (factors which cannot be treated here) create the real blockade.

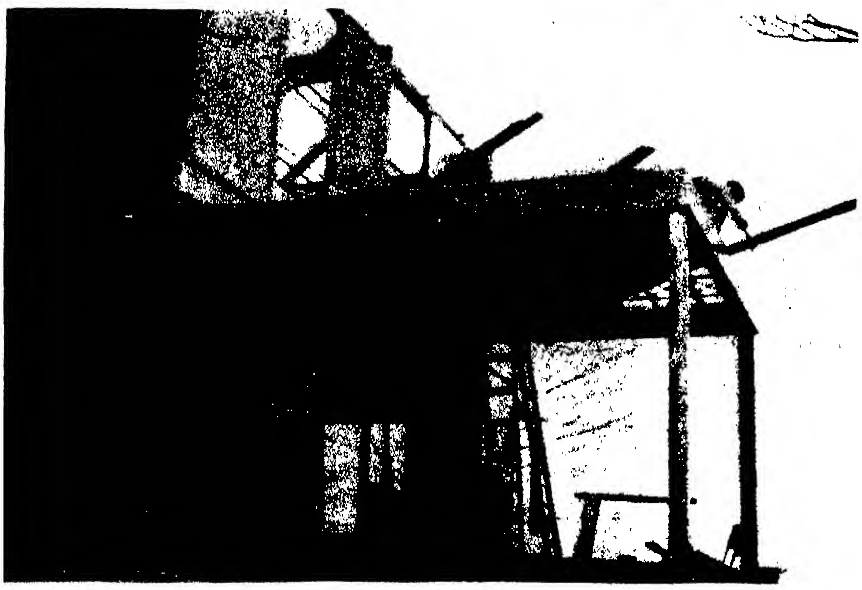
COSTS do loom large as an obstacle to construction. Compared with any other modern industry of like size and importance, building is far too costly and backward. Methods have changed little in past centuries. Bricks are still laid one by one, lumber is still cut piece by piece, and the finished product differs little from what our forefathers enjoyed. Costly methods still prevail and it is this front upon which the pre-fabricationists make their attack.

The pre-fabricator claims there are four elements to the building problem. There is waste, he says, in small scale operation with a contractor-architect, financer, wholesale supplier, and numerous crafts biting off a little piece from each individual job. Better by far to concentrate functions under a single head to serve many units. This, they say, would make possible purchase of materials in quantity at rock-bottom prices.

Large-scale purchase solves the first of the four elements in the building

problem. The second is met by obtaining better materials—better in the sense of being more easily and inexpensively fabricated into form. If this is done, says the pre-fabricator, it would not only reduce fabricating costs, but would contribute to a solution of the third problem which is one of cutting assembly and erection costs on the site. Quite logically, solution to problems two and three transfers the handling of much labor from site to factory where it would be possible to bring about further cost reductions and to give labor more steady employment at a more controllable hourly wage, thus solving the fourth, or variable labor wage, problem.

Pre-fabrication then really means revolutionizing construction to make possible application of our very highly developed machine technology with its inherent cost saving. It involves standardization, integration, and mechanization.



A minimum number of studs and other framing pieces are required in this pre-fabricated modern steel house. *Above:* inserting window frames. *At left:* constructing the porch roof over a steel framework

All this sounds very new, but strange to relate, pre-fabrication is old. Building materials have been factory-made for a very long time. What is attempted now is an increase in scope of factory treatment. Nor is standardization wholly new; the idea is simply carried much further. Portable houses, "ready-cut" structures, the "knock-down" house, all are examples of pre-fabrication and they date back as far as 40 years. It's just that we haven't thought of them as forerunners. Even the pre-cast concrete slab house, about which much is written in the news, isn't new. The writer recalls describing nine years ago a process by which hollow walls of concrete could be factory cast and set up to make houses of many styles at relatively low cost. Such a house was actually erected at that time and still stands in one of the boroughs of New York City—a low cost structure; six slabs forming floor, ceiling, and walls of each room; weatherproof, admirably insulated, and inhabited by a contented pre-fabrication enthusiast.

Early experiments in pre-fabrication made little or no progress. Why? Because the public wasn't ready for it. Factory-made houses required a large market to assure cost savings, and economic pressure was insufficient to force consumer acceptance of the unconventional on a wide scale. But the seeds were sown, experimentation was continued by a few firm believers, and present-day pre-fabrication draws upon years of trial and error in the creation of moderately well-tested products, as is demonstrated by examination of practices.

Steel, concrete, and plywood are the three basic materials with which pre-fabricators are working and there is practically no uniformity of practice. Each producer has his peculiar type of construction and combination of materials, but all strive to obtain a standardization which is practical. Efforts are directed toward contriving a few simple forms which will permit some variation in design while co-ordinating frame construction with standardized exterior and interior panels, doors, and window frames. No matter what the materials used, all components must conform to a definite module so that parts have a maximum interchangeability. The greatest divergence is found in methods of joining, binding, and fitting the pieces and forms of materials together to make a unified structure.

Steel is the most recent material put into commercial use. Structural steel shapes or fabricated light steel strips are being used for frames. For walls, the form is in cells or pans, the former providing a hollow wall which is filled with an insulating material; the latter providing a similar effect when panels or pans are bolted together with an insulating material between. Certain types of steel-panelled structures require no frame, the panels being adequately strong to carry the roof load. Modifications of the all-metal house are found in types using copper and aluminum for walls, or steel covered with a baked enamel finish.[1]

THE proponents of concrete lean heavily to the pre-cast slab, and with very good reason, for enormous strides have been made toward reducing slab weight so that it can be handled without special equipment on the site. Some producers use a wood frame, others steel, and still others have found a way of pre-casting studs, columns, and joists

[1] "Fight Corrosion," July *Scientific American*.

so that the entire structure is concrete. Closely allied in character are types of construction which use panels of cement-asbestos with or without insulating material between and held rigidly or merely clamped to permit free movement under stress.

Plywood is only now getting attention as a possible exterior or interior wall material. Development of synthetic resin glues provides a binding substance for the laminations which excludes moisture, fungus, and termites; the finished, compressed panel has great strength. One producer offers a panel strong enough to carry most of the roof load when used in conjunction with light steel I-beams and channels.

LESS prominent construction types, though progressing rapidly, employ steel frames and cork board panels ready for application of any chosen exterior wall surface; light steel frames with ribbed aluminum sheet covering: metal lath wall frame and sand-lime pre-cast slabs, reinforced and braced with steel angles.

The foregoing covers the basic types of pre-fabricated structures. Each type has its advantages and disadvantages, but space does not permit detailed criticism. We can only touch upon merits and demerits in a broad fashion and steel is the first subject.

On the score of strength, weight, and thickness, there is much to be said for steel. A steel frame is virtually indestructible, and no termite can eat it. Steel panels, properly designed, provide enormous protection, using very little space. There seems to be a tendency to restrict steel to framing inasmuch as the life of a panel is limited by corrosion. Copper-bearing steel[1] gives increased life and so does painting the surface, but painting is a repetitious job. Corrosion can work from the inside, the attack being made from the unpainted inner wall surface. If strong, non-corrosive metals could be had at sufficiently low price, wide use would probably be

[1]Ibid.

Steel construction permits the use of another modern scientific development: arc welding for the joints

made of them by pre-fabricationists.

Steel frames of the light strip type have proved very satisfactory, but as yet costs exceed that of a well-made wood frame. Structural shapes, though satisfactory in service, are much heavier than necessary and excess weight is a factor militating against low cost.

The pre-cast concrete slab house represents enormous strides over earliest models. Two-inch and even one-inch thick slabs of satisfactory strength are now common and this weight reduction permits handling large units without costly equipment. Their lightness, however, is a drawback because they are rather easily damaged in shipment from factory to site.

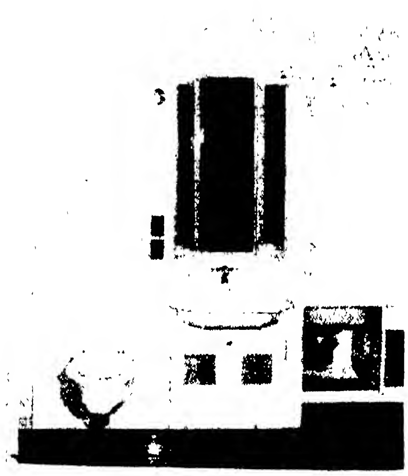
These drawbacks in construction are by no means insurmountable and they do not detract heavily from the basic achievements toward a solution of the home-building problem. Many of the present houses are admirable from the standpoint of being highly livable. There is no question that design has been unified to the end that operation and upkeep are, in most instances, lower; that what are regarded as necessary comforts are well provided and that the buyer gets his money's worth. But what of first cost? Have the pre-fabricationists achieved their aim of providing homes at lower cost?

The answer to this question is: Not yet. The proponents of the new building who have not been carried away by enthusiasm for the products of their own genius will admit that the pre-fabricated house can be duplicated in size and general equipment at identical cost by what they term "outmoded methods," but they will add that the buyer gets a better house—that is, better materials—in the pre-fabricated house.

The pre-fabricator has overlooked nothing in his search for means to lower cost, but there are definite limitations in his way. These should be considered here before making a final appraisal.

IT would seem but common sense to get back to fundamentals and ask where the possibilities of savings are. Here we get at something significant. Since most building materials are already factory made, the possible saving is in extension of the factory process in order to reduce the cost of direct labor on the site, and since this approximates 25 percent of the total home cost, here is the place where a dent can be made and *is* being made. Framing a seven-room steel house in 75 man-hours testifies to this. Even so, 15 percent represents about the maximum possible saving in site labor, since there will always be such non-factory items as foundations, sewer connections, sidewalks, and so on.

It is important to note, too, that the use of "better materials" is somewhat dictated by the transfer of labor from site to factory. Materials must lend themselves to machine fabrication if the machine is to contribute to cost saving. Substantial reductions incident to factory treatment depend upon large scale operations, which in turn require a



Partially assembled bathroom side of a new steel unit-house. In this "core" will be all mechanical, plumbing, heating, and electrical devices for the entire home. *At right:* Its steel frame, with wall panels of asbestos and concrete

Research in construction is not enough; research in "liveableness" is every whit as important. The two-story house shown here, constructed as illustrated on the opposite page, has been lived in for over two years and found to be exceptionally comfortable

large market, and that market is not an immediate one though it may be an eventuality.

Aside from cost barriers, there are others militating against the pre-fabricated house. Labor organizations do not relish the oncoming of factory operations which would necessitate a violent readjustment of the many crafts, accompanied by a certain amount of hardship; building codes, fashioned with older methods and time-tried materials in mind, preclude from certain localities these newest products of the pre-fabricator's art. Finally, standardization, so essential to the proper functioning of the entire idea, restricts design variation and thus alienates a large body of potential buyers—the people who now have the money and could purchase at prevailing prices.

In presenting these obstacles and drawbacks to pre-fabrication, nothing has been portrayed but a picture of the moment. Many of the barriers, very real at this writing, are but transitory. Pre-fabricators tell us that transfer of labor from site to factory will give steadier employment and ultimately create new jobs. Eventually the drawback of obsolete building codes will be removed. A code cannot long stand unamended against a demonstrable improvement which means so much to the community. Even standardization, creating a monotonous product, is not a real barrier.

The rock-bottom in possible savings is still in the future. If there is a limit to the reduction of labor costs on the site, there is still an opportunity to work back to cut material costs themselves. Pre-fabricators dream of materials not yet originated which, perhaps, will be made from waste materials or from very cheap bases. They vision improvement in existing materials to give them new qualities, enhancing their utility and value many fold. Recent years have given stainless steel, copper with the strength of steel[1], plastics to form at will[2], more durable paints[3], and concrete which bears little relation to the material which you've seen made up of cement and sand, watered indiscriminately.

THERE is more than supposition in the idea that we are on the eve of startling developments. There are several admirable products in existence now which a change in selling policy would place at the disposal of those seeking low cost building materials—products having low base and production costs when made in volume, but held in the upper brackets until some competition forces cultivation of markets through low price appeal. Even such well-known materials as wood and concrete may be brought to the fore after basic research into their characteristics reveals ways to make them more serviceable. It is to the work of the research chemist, prompted by the pre-fabricators' demands, that we must look for the means to achieve the goal that pre-fabrication has set.

It has been said that home ownership is largely a matter of heart rather than of head. This thought is expressed whenever criticism is made of the somewhat box-like appearance and flat roof of pre-fabricated houses. And it is true. But just the same, it is a wholly functional design, indigenous to the machine age, and the idea supplies the first break with tradition having any force behind it. This presages faster development.

Pre-fabrication gives an opportunity to develop architectural style anew, taking into consideration all modern advances. Its proponents can design, for example, with full appreciation of the freedom oil burners give to utilize basements, and of the new fundamentals involved in air conditioning. They can roam in a field of materials which the architects of traditional design never imagined and they can design for living rather than to perpetuate a design imposed by earlier, sometimes ancient, limitations.

Existing pre-fabricated houses are not to be regarded as the final word. Excellent as they are—superior in many respects to the majority of homes now standing—they are but milestones along a new industrial road. They are the tangible symbols of an idea which has vitalized the thinking of the building industry and drawn to it the creative efforts of a host of contributors. The pre-fabricated house isn't going to run like wild-fire across the country; the immediate market isn't anywhere near as large as many people imagine. But it may easily spur the development of a structural method making possible homes at substantially lower cost. When that happens you will have seen its real potentialities expressed. Meanwhile, pre-fabricated houses are on the way.

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[1]Ibid. [2]"Plastics Come of Age," January *Scientific American.* [3]"Paints in Transition," April *Scientific American.*

Photograph of completed home on page 66 courtesy *The Delineator.* Other photographs courtesy American Houses, Inc.; Connecticut Pre-Cast Buildings Corp.; The Lincoln Electric Co.; The Ultimate Home Corp.

WHAT ARE POSITRONS?

By E. U. CONDON
Associate Professor of Physics, Palmer Physical Laboratory, Princeton University

NO matter for how many years an editor has studied the reader reaction to his own particular publication, and no matter how well defined is the editorial policy of the magazine, the editor must still lean heavily upon the ideas of readers expressed in letters to him. Recently we have received quite a number of letters asking specifically for more articles of the so-called "heavy" type such as the accompanying one. We think those readers who have written are right but we want to be sure. Will you not, therefore, sit down and write us your exact reaction to the accompanying article, which will thus serve as a test of the average reader's wishes? Prior to publication some judges thought this article too stiff for the average non-professional reader, while others believed that the readers do not want lighter articles than this. What is your vote?—*The Editor*.

EVERYONE knows that there are two kinds of electricity, called positive and negative, and that the like kinds repel each other while the unlike kinds attract each other. These amounts of electricity occur in nature in small units of charge which behave more or less like little particles. The smallest unit of charge which ever occurs in physical experiments was accurately measured by Millikan in his famous oil drop experiment, and was found to be so small that 6.3×10^{18} of such charges pass in one second in an electric circuit in which the current is one ampere. Such small units may be positively or negatively charged.

But there is a big qualitative difference between the basic positive units and the basic negative units as they ordinarily occur in nature. Knowing the charge on one of these tiny units, it is possible to measure their inertia by arranging to have them going in a beam which can be deflected by the electric force between the plates of a condenser. This is the idea underlying the cathode ray oscillograph which is beginning to have so many technical applications. The more inertia the particles of the beam have, the less they will be deflected by the same field, other things being equal. In this way it was learned that the negative particles have much less inertia than the smallest positive particle. In fact, such measurements show the inertia of the smallest positive particle to be some 1840 times that of the negative particles. These light and very mobile units of negative electricity are what the physicist calls electrons, and the 1840 times as massive unit of positive electricity is what he calls a proton.

THIS lack of symmetry between positive and negative has always been very puzzling to physicists. All the theories that have been developed so far show no reason why the positive and negative kinds of electricity should behave differently with regard to the inertia of their basic particles. And why, of all numbers, should the ratio of the two inertias be just 1840? I do not ask the question rhetorically, in order to answer it in the next paragraph, for it is one of the outstanding questions in physics today and no one knows the answer.

The foregoing represents the situation as it stood until one night in August, 1932, when Dr. Carl D. Anderson, of the California Institute of Technology, discovered the positron. What, then, is the positron? It is simply the name physicists gave to a new kind of positively charged particle which Anderson discovered, which has the same amount of positive charge as the electron has of negative, *and* has the same small inertia that an electron has, instead of 1840 times as much, as was the case with the least inert form of positively electrified particle hitherto known.

So, perhaps, you may say, the symmetry between positive and negative electricity has been restored; for now we know that both kinds of electricity can occur in particles of the small inertia of the electron. But it is not so simple as that. Why was the positron not discovered until some 35 years after the properties of the electron were first studied? If no one had ever looked for such things you could ascribe it simply to negligence, but physicists have looked for positrons or positive electrons in many ways and in many places. The fact is that negative electrons are exceedingly common. They are a principal constituent of the atoms of all matter, they leak out of hot metals in radio tubes, they bombard the anti-cathode of X-ray tubes in every dentist's X-ray outfit, and so on. Positrons, on the other hand, are a great rarity. Apparently they do not have a permanent existence at all, so that under ordinary circumstances they simply do not exist. If we want to study them we practically have to arrange matters so that we can make them.

So the lack of symmetry between positive and negative electricity which has been so puzzling is just as real today as ever, but it bobs up in a different place. There is no longer a lack of symmetry with regard to mass of the least inert particle of each kind of charge, but there is a great lack of symmetry in the natural abundance of the two analogous particles—electrons and positrons. Electrons are everywhere, positrons can be found only under the most exceptional circumstances.

LET us then consider a few of the circumstances under which positrons are found. Their discovery was a by-product of the great cosmic ray research program of the Norman Bridge Laboratory in Pasadena. Anderson, working with Millikan, had arranged a Wilson cloud chamber between the poles of a large electromagnet. A cloud chamber is a device invented by C. T. R. Wilson of England, for rendering visible the paths of high-speed electrified particles as they go through a gas. As the high-speed charged particles go through the gas they knock electrons out of the gas molecules through which they pass. Thus they leave a trail of charged molecules or ions in their track. If the gas is saturated with moisture, in a chamber containing a piston which can be suddenly expanded, then the track of ions is made visible on expansion; for expansion cools the gas and makes the moisture condense out in little droplets. The droplets form most readily on the ions, since the electric charge helps the droplet to form, and thus the path is shown as a fine trace of water droplets which can be photographed.

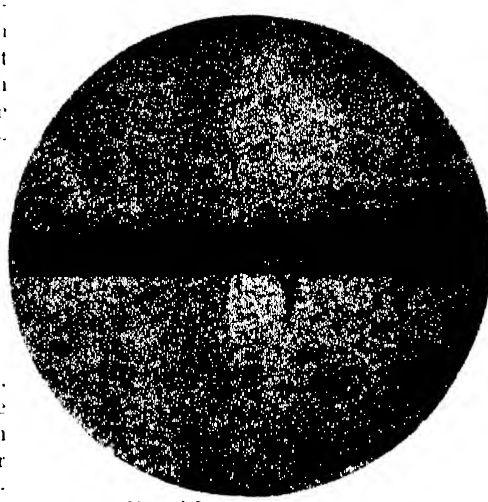
Discovery of a Positively Charged Counterpart to the Negative Electron, That Can Apparently be Created and Destroyed . . . Dirac's Theory . . . All Space Filled With an Infinite Number of Electrons That Can Never be Directly Observed

Anderson's historic photograph, which first revealed the positron, is shown in Figure 1. Hold the page in a vertical plane and imagine yourself looking at the picture through a hole in one pole of the big electromagnet, for that was the location of the camera. The horizontal strip across the middle is the edge of a lead plate located in the cloud chamber. The thing of vital importance is the thin little trail of droplets which is to be seen both above and below the plate, and bent so as to be concave on the left side. That is the path of a high-speed particle somehow associated with the cosmic rays, going so fast that it went right through the quarter-inch lead plate, but not so fast but that the powerful electromagnet was able to deflect it from a straight-line path into the curve shown in the photograph.

The forces which deflect such a particle are of the very same sort that come into play when current (that is, a stream of charged particles) is flowing in the armature of a motor and is acted on by the magnetic field of the fixed or field magnets. There can be no doubt that the particle which made this track was moving from the bottom of the picture to the top, for the fact that the track is less curved below the lead plate shows that it was going faster in the lower half than in the upper, which made it less deflectible by the magnet. The slowing down in going through the lead is due to loss of energy caused by collisions with the electrons and nuclei of the lead atoms. From the direction of the field of the magnet, and the fact that the trails are concave to the left, it can be definitely concluded that the particle which made the trail was positively charged: concavity to the right would be demanded for the case of a negative particle.

NOW how does Anderson know that the trail was not made by the already well-known proton, of 1840 times the mass of the electron? Because a proton which was deflected as much as this particle in the lower half would have to be going much slower, since deflectibility in the magnetic field is measured by the product of inertia and speed. And if it were going that much slower it would not be able to penetrate the lead and still have enough energy to go as nearly straight as it did go in the upper chamber. These are not hypothetical statements about the proton, for the proton is well known and its ability to go through lead for different speeds is known from other experiments.

To be sure, such experiments as this alone do not suffice to measure accurately the inertia or mass of the particle, but they suffice to show that it is about the same as that of an electron. After the discovery, other more exact measurements have been made which show that the new particle's mass is probably precisely that of the electron.



Courtesy Physical Review

Figure 1: **A high-speed positron, with lowered speed (shorter radius) after passing through lead plate**

From the curvature of the paths Anderson could say what was the amount of energy of the positron which produced the track. In this kind of work energy is usually expressed in "electron-volts." An electron-volt is the amount of energy that a particle of charge equal to that of one electron gets when it moves through an electric potential difference of one volt. Thus an electron, in going from the zinc pole to the carbon pole of a common dry cell, gets 1.8 electron volts of energy if 1.8 is the voltage of the dry cell. But it does not get up much speed because it is continually losing this energy in collisions with the atoms of the wire through which it moves. In a vacuum tube, where collisions are rare, the energy accumulates as energy of motion or kinetic energy. In experiments of this sort one electron-volt is a trivial amount of energy—we deal in millions. Measurements show that, before going through the lead, the positron in Figure 1 had an energy of 63,000,000 electron-volts, and emerged with an energy of 23,000,000 volts, the other 40,000,000 having been lost in going through the quarter-inch lead plate.

Since this first picture was taken, large numbers of other pictures of the same sort have been made, which show the association of these positrons with cosmic rays. The first work confirmatory of Anderson's discovery was published in the *Proceedings of the Royal Society*, by Blackett and Occhialini of the Cavendish Laboratory in Cambridge, England. Since then, positrons have been observed in many laboratories, and a large amount of research is now in progress in which their properties are being studied.

SUBSEQUENT research has shown that it is possible to obtain positrons without the aid of cosmic rays. Anderson has shown that when the gamma-rays (high energy form of X-rays) from Thorium C″ (a radioactive substance whose gamma rays are especially penetrating) strike lead or other matter of heavy atomic weight, positrons are ejected. The general experimental arrangements are similar, in that cloud chambers are used to study the tracks of the ejected particles and a magnetic field in order to tell from the kind of curvature both whether the particle is positive or negative and the amount of its energy of motion.

Experiments of this sort show that positrons and electrons come out of the lead in pairs. Coming from a definite place in the lead there are two tracks, one curved as for a positron, one as for an electron. This is the new result. That gamma rays can knock out ordinary electrons by themselves has been known for a long time. All the details that have accumulated would make a story too long to tell here. Suffice it to say that the evidence is that the gamma ray, passing near the nucleus of a lead or other heavy atom, is actually able to create out of nothing a positron and an electron.

It is not quite right to say "out of nothing," for that would be a violation of the principle of conservation of energy, a principle with no exceptions thus far in any part of physics. What appears to be happening here is a conversion of the "non-material" energy of the gamma rays into a material form, the material form being the two charged particles, one positive, one negative. Other experiments have indicated that the reverse process may also take place —that a positron, passing through an atom, may unite with one of the electrons in the atom in such a way that they

are mutually destroyed as material particles. Their energy then appears as a gamma ray. In such experiments we are actually dealing with a conversion of energy into matter and of matter into energy, such as was first postulated in 1905 by Einstein as a consequence of the theory of relativity. (A new derivation of this theorem was presented by Einstein at the Pittsburgh meeting of physicists in December 1934. See SCIENTIFIC AMERICAN cover picture for March 1935, and short note on page 113 of the same number.)

By Einstein's theorem it is easy to calculate that the energy needed simply to create a particle of the mass of an electron or a positron is equal to about half a million electron-volts. So an energy of 1,000,000 electron-volts is needed to produce a pair of particles. Now the energy of the gamma ray from Thorium C″ is known to be equal to 2,620,000 electron-volts. One way in which this is known is by the fact that, when such a gamma ray ejects an ordinary electron from an atom, the ejected electron is found to have this energy by deflecting it in a magnetic field in a cloud chamber.

BUT when the gamma ray of Thorium C″ produces a pair it is found that the energy of motion of the positron, plus that of the electron, amounts to 1,600,000 electron-volts. This indicates pretty plainly that the other million electron-volts was used up in the actual creation of the particles themselves.

In the three years since Anderson's basic discovery many studies of positrons have been made. Important among these is the experimental proof, by Thibaud and Dupre la Tour, that when positrons go through lead, a gamma radiation is emitted of the correct energy to correspond to the converse process to the above—in which an electron and a positron are annihilated, with the mass equivalent to their energy reappearing as two quanta of gamma rays. Positrons also appear in the experiments of Irene Curie and F. Joliot, in which the lighter elements are made artificially radio-active by bombardment with alpha particles.

We still have to consider the question of why the electrons occur abundantly in Nature, and why the positrons are so rare. An ingenious answer to this question is afforded by a theory due to P. A. M. Dirac, the present holder of the professorship in Cambridge, England, which was once held by Sir Isaac Newton. This theory is still in a quite provisional stage, and there are difficult points about it which no one understands, not even Dirac. But it also has many things in its favor, and at any rate it is the theory in terms of which physicists think of the positron at present.

In 1928 Dirac developed a theory for the behavior of the electron, which would both satisfy the requirements of the quantum theory and be consistent with Einstein's theory of relativity. One feature of this theory was that, according to it, electrons could have negative amounts of total energy, just the same as if they had a negative mass. Now negative mass is a rather bizarre concept. Mass is the physicist's measure of inertia, and it measures the amount of force needed to speed up the particle. Using the equations, a particle of negative mass would have such a property

Figure 2: **Dr. P. A. M. Dirac, whose positron theories are receiving support from actual experiment**

that, if you were to push it to make it go in a certain direction, it would actually start moving in the opposite direction, and the harder you pushed it the more it would pick up speed, but always just backward from the normal behavior. When any theory gives such a strange result it is naturally to be viewed with suspicion, for no such peculiar particles have ever been found in Nature. But the theory was so completely satisfactory in so many other respects that it was not to be tossed over lightly.

Another point to notice is this: any system of electrons always tends to radiate light waves, and so to get rid of its energy as much as possible. In Dirac's theory this would mean that ordinary electrons would emit light and go over into the negative energy and negative mass states, unless something were there to stop them. The only thing that could stop them, theoretically, would be if, in so-called empty space, there were already present such a large number of the peculiar type of electrons that there would be no possibility for the ordinary electrons to emit light and go over into the peculiar condition. This implies filling what has hitherto passed for empty space with an infinite number of the peculiar electrons! But that is the postulate which Dirac makes. He says simply that, as they are always there, we do not notice them in our experiments, for experiments only show *changes* in things. It is an absolutely constant feature of our environment which thus escapes attention unless a change in it occurs.

In this great ocean of peculiar unobserved electrons, present everywhere, some special conditions may arise (such as the passage of a gamma ray near a lead atom nucleus) which result in one of the peculiar electrons being knocked up into a state of the usual positive energy and positive mass. If this happens, *two* things become observable. One is the electron that is knocked up into the normal kind of state. The other is that there is now a hole in the otherwise full distribution of electrons of the peculiar sort. This hole, according to Dirac, is the positron. A little thought will show that the hole will behave normally after all. A tiny air bubble or hole in a tank of water will rise. That is because the water is pulled the other way by the earth's attraction. So, likewise, if we have an ocean of electrons of the peculiar sort, with the property that pushing them away makes them come toward you, then a force acting on the ocean will make the hole appear to move in the normal sensible way; namely, it will pick up speed in the same direction as the force acting on it. Also, since at the hole there is one less charge than the normal amount of negative electricity, the hole will count in the equations like a positive charge. (This is just like the case of a man who became so accustomed to being 1000 dollars in debt all the time, that he considered himself to have a dollar when his debt was reduced to 999 dollars!)

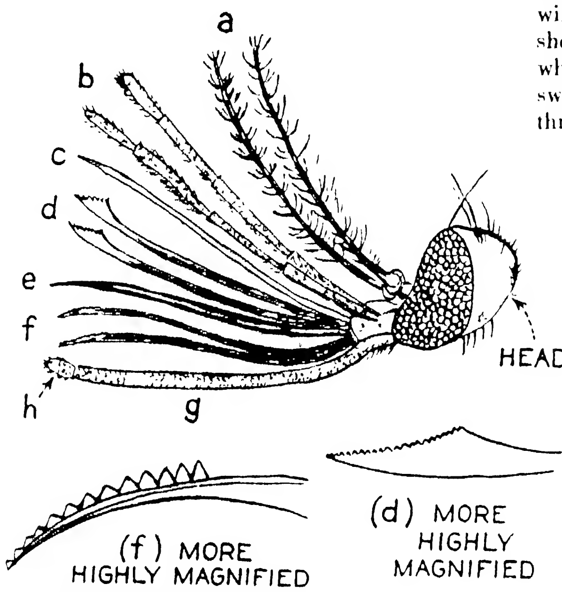
OBVIOUSLY, on this view, there is a big distinction between the electron and the positron—just the distinction that is necessary to account for the fact that electrons are abundant and positrons rare. For the positron is just the absence of an electron from the ocean of peculiar electrons. It may be destroyed at any time by having an ordinary electron jump in to fill the hole. But the ordinary electrons have a persistent existence simply because there are enough of them in the world to fill up all the holes in the peculiar states which we ordinarily do not observe, and enough more to provide the ordinary electrons with which physics has long been familiar.

To the plain man such a theory may sound pretty fantastic. I think most physicists themselves find it rather hard to believe. But it does coordinate the experimental observations quite nicely, and no other theory has as yet been proposed which does as well. After all, such a situation is all that ever gives any theory scientific status on a stage of shifting fundamental ideas and ever-increasing array of experimental facts.

The Lady Mosquito and Her Pocket Jack-Knife Tool Kit

By GEO. A. SKINNER, M.D.

PROBABLY, if you have ever wondered just how mosquitoes bite, you thought they bit by prodding you with a single awl. As a matter of fact, they do not bite at all. Instead, they saw a hole through your skin, then insert a most perfect hypodermic needle and proceed to fill up on good red blood.



Drawing by the author, after Nuttall and Shipley

Figure 1: **The mosquito's collection of gadgets**

If that were all they did it would not be so bad—though bad enough to cause much irritation of the skin, and occasionally some cussing, when the bite is in an especially tender place. And the mosquito has a way of picking out the tender spots, for she feels around and finds one to her liking before starting her carpentry work. It is only the female that bites, for the gentleman mosquito does not live on such coarse food as blood. He seeks the nectar of flowers, and the like.

After the lady mosquito has sawed a hole through your skin she injects through the tube *c*, Figure 1, some of her own saliva, so that your blood will not clot. Incidentally, this is what causes the itching. But in doing this she is likely to inject things that are unfriendly to the human being, such as malarial parasites, tiny worms, called filaria, and the like. We do not have much of this in the north, and most of the mosquitoes north of Missouri are comparatively harmless.

SUPPOSE we look at the tools that Mrs. Mosquito carries. Her kit is admirably designed for the purpose it serves. When we first look, even with a magnifying glass, all that we see is a pair of short, feathery projections and a tiny tube, like the trunk of a very tiny elephant. But this is no ordinary trunk; it is a complete tool kit. Suppose we examine it further.

There are two feathery "feelers" or antennas—Figure 1, *a*—which contain her ears, and seem to play an important part in connection with her too-efficient sense of direction. Then there are what appear to be eight little hair-like projections, which must be "teased" out of their sheath. These look harmless enough, but let's take a stronger glass, so that we may see them more clearly. Now the tools begin to be apparent. First, we see two rather tube-like hairy projections, *b*, that are jointed. Next, there is a beautifully sharpened, long hypodermic needle, *c*. Then two little saws, *d*, on long handles. Next, a sword-shaped blade, *e*. Then two more saw blades, *f*. Then, below them, what is really the case for the tool kit, *g*. This sheath or scabbard, which is really the lower lip, has two little hinged ends, *h*, which are delicate feelers, by means of which the mosquito is able to locate a nice soft place to start operations.

Now look through a still stronger glass at the saws *d*, shown below in the same figure. Each of this pair has some 30 teeth. Each of the other pair, shown more highly magnified at the left, has 13 teeth, all sharp.

We will assume that the mosquito has now alighted on your skin and has prospected around and found a satisfactory place to collect a meal. How does she get it? First, she moves away the two tubes at the top (*b*, Figure 1). Then she starts the two pairs of saws, *d* and *f*, going, and soon she has made a fair sized opening. If you watch her you will see that she weaves her head and shoulders, as does any husky carpenter when sawing. Then she slides in the sword point *e*. This is hollow, and through it she injects her saliva to keep the blood from clotting (also, she may inject various germs). This hypodermic is used only to pass fluids out, as it connects directly with the salivary glands. As she gets further through the skin, the scabbard, or lower lip, *g*, does not enter the wound, but bends back out of the way. (Figure 2.)

NOW she commences to work the other hypodermic syringe, *c*, which is used only to take in food, and the blood is drawn into the stomach by a suction-like action imparted by the little muscles around the head. Watch her commence to swell. In about three minutes she is so full that she can scarcely fly.

When she has all the food that she can carry, she packs up the tool kit and flies away to rest and enjoy the meal—and you have a mosquito bite.

YOU can readily tell whether the mosquitoes at your camp or home are dangerous or not, by watching them when they alight. If they stand with the body parallel to the surface on which they are resting, they are not disease-bearing in northern countries. If, instead, they appear to be standing nearly on their heads, they are dangerous and will convey disease. The eggs of harmless mosquitoes are in rafts or masses.

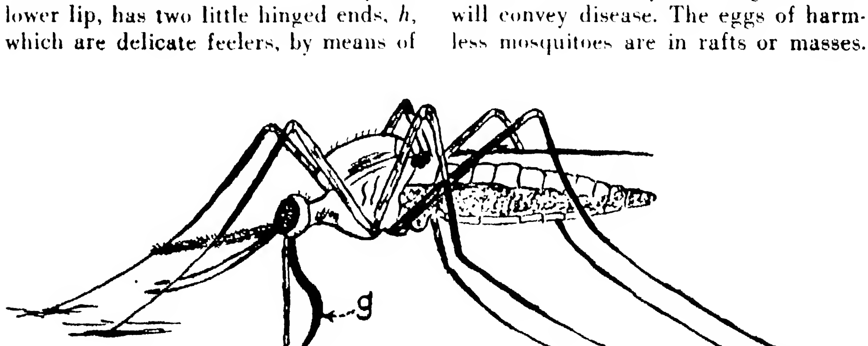


Figure 2: **The sword is in but not the scabbard *g***

When a Snake Bites You

Serum is not Sufficient . . . Prolonged Mechanical Suction is the Basis of the Highly Successful San Antonio Treatment . . . Now Used by U. S. Army

By W. A. BEVAN

In the treatment of snake bites, it is believed by some that too much emphasis has heretofore been laid on the value of serums, and too little on the value of prolonged mechanical suction for removing the snake's venom physically from the bite. A technique developed largely by a group of men in San Antonio, Texas, particularly by Dr. Dudley Jackson who has probably had a larger personal experience in treating snake bites than anyone in this country, rather reverses these emphases, placing main stress on the removal of the venom, though not denying serums to patients in whom the mechanical treatment has been delayed or ineffective, or in such cases in which the venom enters the general circulation. People at large have probably overestimated the value of serum treatment for snake bites.—*The Editor.*

WIDE publicity has been given to new developments in the treatment of snake bite, but most persons first want to know how to avoid being bitten and what constitutes adequate protection against being bitten. Undoubtedly the best protection against poisonous snakes is a keen eye. With few exceptions, the only dangerous snake is the one you do not see. It is generally the snake under a log or rock, hidden in brush or grass roots and inadvertently touched or stepped on, which strikes. The snake you see a few feet away from you will do no harm, provided you stay away from it.

"But," says the man who goes afield for sport, "I want to think of other things than snakes when I am in the wild. What protection are boots?" Obviously, this question is one of mechanics.

Recently a number of tests were made, by causing poisonous snakes to bite different boot leathers fixed to the tops of venom-collecting glasses in such a manner that the poison could be found if any went through the leather. Those who conducted these experiments, Robert F. Harvey and the author, both of San Antonio, Texas, have been bitten many times by rattlesnakes, water moccasins, and copperheads, and know that snakes bite with even greater force when held by the neck than when they embed their fangs at the end of a well-aimed strike.

IN one experiment a small water moccasin was permitted to bite a piece of thin outer leather used with a heavier leather lining in riding boots. This leather has the same thickness and texture as that used in the uppers of lightweight lace boots. The moccasin bit the leather a number of times, making many scratches, until both of its fangs broke off, but did not puncture the leather. A rattlesnake nearly five feet long bit the same leather, but failed to pass its fangs through. This failure to penetrate the light outer leather makes it unnecessary to experiment with the two thicknesses which make up the leg of a riding boot.

Figure 1 shows a large rattlesnake biting the lightest weight leather used in leather leggings. The large, curved fang, still encased in its skin sheath, can be seen with its point caught in the leather. The venom is evident behind the fang.

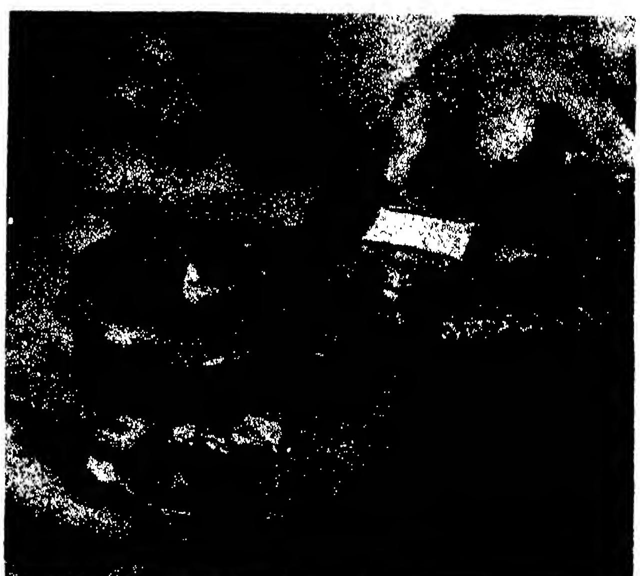
As the largest snakes of this country seldom bite above the calf, most of the bites being in the lower third of the leg, substantial boots afford sufficient protection to relieve the wearer of anxiety, provided he can remember to use his eyes before he steps.

Rattlesnakes are abroad on warm nights and the camper should sleep on a raised cot as a precaution. If you can sleep better with a hair rope around your bed, put it there, but don't expect it to make a rattlesnake even hesitate. It is not necessary to place a rattlesnake within a rope circle in order to prove that it will cross the rope; in those circumstances the snake could not go anywhere without crossing the rope. If a hair rope is simply thrown on the ground, any rattlesnake will cross it without any particular inducement or coercion, as did the snake in Figure 3.

In a rattlesnake-infested country wear heavy boots and, if you wear long trousers, wear them outside the boots; for a snake will not stop to figure where the leg itself is, and will bite at what it sees—which will be the trousers.

Within recent years many articles on the treatment of snake bite have appeared in the better magazines, some of them by professional writers who evidently lacked a first-hand knowledge of the subject, and who do not know that serum plays no part today in the treatment of snake bite in the one institution where the snake-bite mortality is lower than anywhere in the world where there are dangerous snakes. The Robert B. Green Hospital in San Antonio, Texas, treats more cases of rattlesnake bite in three months than any other institution in this country treats in as many years.

The highly successful technique used in the Robert B. Green Hospital, and recently accepted for use by the entire United States Army, by direction of the Surgeon-General at Washington, was



All photos by Jack Specht

***Figure 1:* This large rattler was unable to puncture the lightest leather used in leather leggings. Note the venom**

developed by Dr. Dudley Jackson, through intensive research started in 1927. Little or nothing could be learned about snake bite from clinical reports—the experience of doctors—because of the great variability of such bites, and the absence of any knowledge of the two factors necessary for the formulation of an opinion. In a given case of snake bite, brought to the doctor, the doctor has no way of ascertaining how much poison the snake injected, nor can he foretell the effect of a given amount of venom upon a patient of a given weight, for the effect cannot be predicted. Patients vary. What, then, would be the truthful answer if we asked the doctor: "Then what would have happened in this case without your treatment?"

Figure 2: **A remarkable action photograph, made *after* it had been ascertained that snakes cannot puncture heavy leather. Note 180-degree opening of jaws, showing how a snake strikes; also rigidity and musculature of the snake's body. The fangs hung for a moment on the trousers**

TO answer some of these questions Dr. Jackson went to work to determine exactly what constitutes a lethal dose of venom for an animal of known weight—and, to shorten the whole long story, every method of treating snake bite was tested under controlled conditions: echinacea, cautery (including gunpowder), ammonia, potassium permanganate, turpentine, kerosene, rattlesnake bile—all were investigated. The only treatment which was uniformly successful was surgical: deep, multiple incisions at and around the site of the bite, and the removal of poisonous fluids by the application of suction cups (Figure 4) at intervals for an extended period, often two days.

The information gained from the first hundred experiments was clinically applied, and the death rate in snake-bite cases immediately dropped. When these experiments were being made, serum was also used and tested, exclusively in a few cases, and later in conjunction with the surgical treatment. Several years later a check was made of all available data on snake-bite cases at the Robert B. Green Hospital, the cases being grouped according to treatment. Of the cases listed as non-specific because they had no adequate treatment, as it is now known, 14 percent died. Only 14 patients were treated with serum alone, and of these two died. Since the incision and suction treatment was instituted, seven years ago, there have been only two deaths, thus giving a mortality of less than 2 percent.

Snake venom is a powerful irritant, setting up a rapid outpouring of lymph from the blood, which causes swelling. In the swollen area there is a mixture of venom and lymph, which is slowly absorbed through the lymph channels. In the San Antonio treatment the absorption of the venomized lymph is retarded by the application of an elastic tube tourniquet, which is not placed tight enough to stop the blood circulation. Incisions in the form of a cross are made through the skin, with a pointed instrument, all over the swollen area and to a depth of a quarter of an inch or more. Suction bulbs are applied to remove the contained fluids. After the first long emergency treatment the bulbs are applied for about 20 minutes out of every hour, as long as there is any lymph to remove. During the intervals between suction periods packs soaked in a hot saturated solution of Epsom salts are applied to the bitten limb.

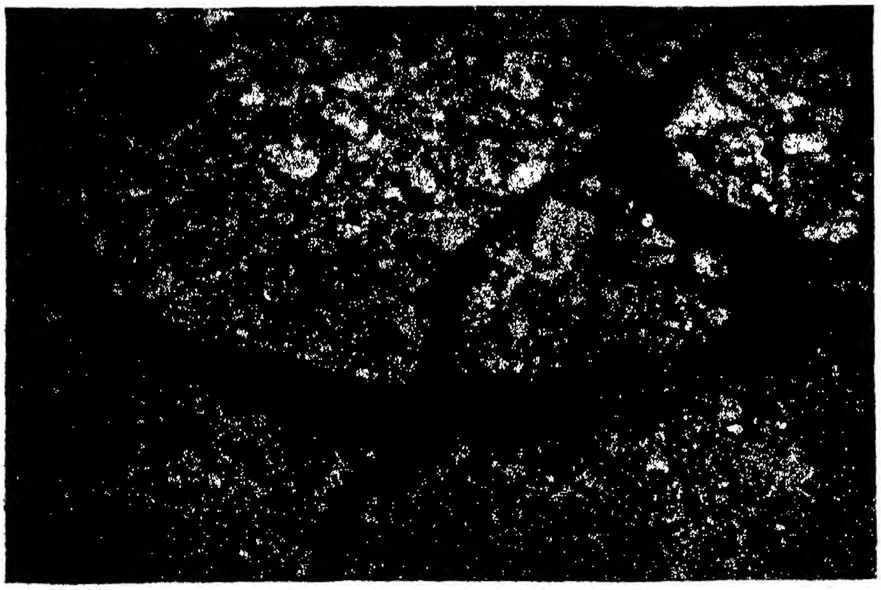


Figure 3: **A Texas diamond back rattler crossing a heavy, rough hair rope. Later, just for the fun of it, the same snake recrossed the rope. Contrary to an ancient tradition or superstition, snakes snap their fingers at hair rope "protection"**

THOSE who are bitten may receive from the snake anything from no venom in a few cases to several times a lethal dose in others. The majority will recover: with treatment, or with no help, or even in spite of mistreatment. Sometimes a snake's fang strikes a bone, and most of the venom is secreted on the outer skin. Often fangs are embedded and withdrawn so quickly that very little venom is injected, even though it is secreted at high pressure. But in a minority of snake bites the snake embeds its fangs deeply, holds on for a fraction of a second, and injects a killing dose of poison. In a majority of

snake-bite cases, incision and suction, properly carried on, is the only treatment necessary. Salt solution in the veins is used for shock, or as an emergency measure when a patient is markedly toxic, as evidenced by pulse and respiratory changes. In a highly toxic case a blood transfusion from the patient's father, brother, or any suitable donor, is used, and this can well be called a great life saver.

In 1931, in continuation of the earlier research in the treatment of snake bite, as much as 2000 cubic centimeters of serum were tried in experiments. As a result of these tests, The American Medical Association, through its Council on Pharmacy and Chemistry, officially revised its description of snake bite serum to read as follows: "In consideration of the work of Jackson, the Council decided to revise the description of Antivenin (Nearctic crotalidae) to state that 'Recent observations seem to show that there is great advantage in giving the serum in the vicinity of the bite. Use of the anti-toxin should never be allowed to replace first aid measures, especially local incision and suction. Perhaps 50 cubic centimeters of the serum is as small an amount as is likely to prove beneficial.' "

SINCE the American Medical Association regards 50 cubic centimeters as the smallest amount of serum which is likely to be of benefit, we may well question the usefulness of the amount of the present commercial dose, namely, ten cubic centimeters. The government permit to manufacture a product does not constitute an endorsement. It has been demonstrated unquestionably that serum will not neutralize venom in its entirety, when mixed before injection and in the ratio in which the government permit was issued, and you cannot get a snake to mix its venom with serum before it bites.

Figure 4: **Suction cups applied to a twice-bitten leg. Note the normal shape of leg 18 hours after bite**

Serum has not been used at the Robert B. Green Hospital in the past four years. Nevertheless, its use in huge quantities at the site of the bite, the only place where it will do any good, is recommended to those who lack the experimental knowledge and clinical experience to gage the gravity of a snake bite. Huge doses will neutralize a part of the venom. The serum has a definite value, but in no circumstances can it be regarded a cure for snake bite, though it can be a valuable aid.

In 1931 it was learned that many microbic infections are present in all snake venom, the gas gangrene organism, *Bacillus welchi*, being practically always present. This organism has been found in most of the snake bite cases from which bacterial cultures were made to date, but it seldom develops in cases surgically treated. The adequate incision and suction of a snake bite is also the best treatment for the inhibition of the complicating gangrene organism.

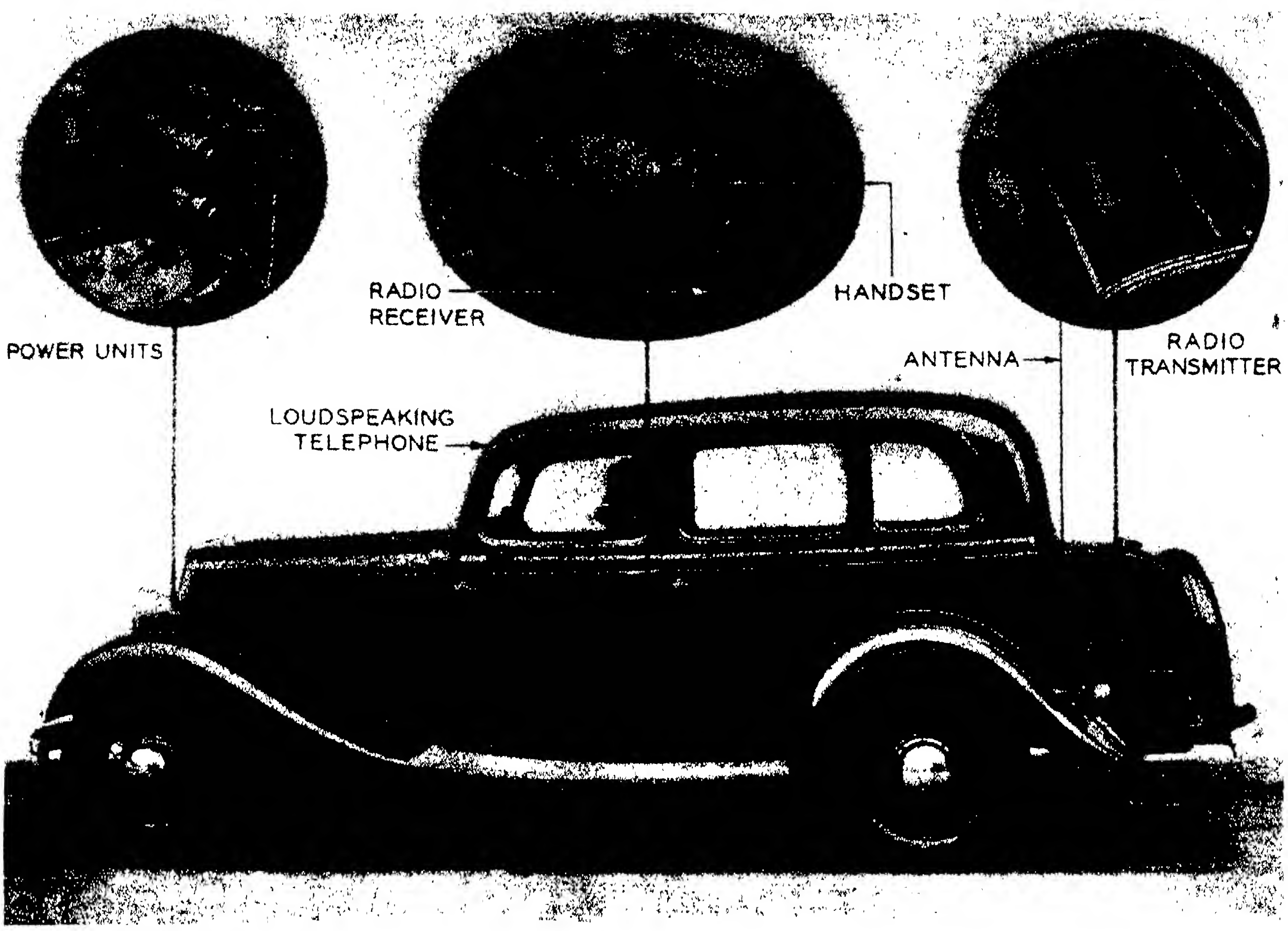
Note the normal shape and appearance of the leg of a man, shown in the illustration (Figure 4), who was twice bitten by a large rattlesnake upon which he stepped, following 18 hours of adequate treatment by incision and suction alone in the Robert B. Green Hospital.

A RAZOR blade (Figure 6) is not a good instrument with which to make incisions in snake bite cases, because too long a cut is made before a required depth is reached. A lot of skin can be cut, causing a lot of bleeding, which increases the likelihood of cutting blood vessels, which in turn necessitates plugging the wound, thus defeating the original purpose. A deep incision made immediately following a bite is, of course, certain to bleed, but in this case the loss of blood is compensated for by the natural irrigation. When additional incisions are made on a swollen area the object is to provide an outlet for accumulating lymph. Bleeding should be avoided as much as possible, and the incision should be made short but deep, as diagrammatically illustrated in Figure 7 at the bottom of the column, using a pointed instrument preferably like the one shown in Figures 5 and 7.

Figure 5: Left: **An elastic tourniquet, suction bulbs, pointed knife—a full kit**

Figure 6: **Darkened area on a white card shows kind of cut razor blade makes. Poor**

Figure 7: **Short but deep incisions are the most satisfactory for treating snake bites. The cutting edge is directed away from the operator. (Note thumb previously damaged by snake)**



Photographs by Western Electric Company

A police car equipped with the latest two-way radio equipment. Insets show close-ups of the important units

The Latest in POLICE RADIO

POLICE radio, now widely used throughout the country, was originally limited to one-way operation; that is, transmission from headquarters to police cars. More recently, advantages have been seen for two-way operation. In addition to receiving orders, the motor patrolman is enabled to report back to headquarters or talk to other cars without leaving his own car. Headquarters, thus in touch with any or all members of its mobile unit, can visualize an entire situation and direct maneuvers with full knowledge of how its forces are distributed.

The two-way police car equipment here illustrated has been developed by Bell Telephone Laboratories and operates in the ultra-high frequency band opened up for police use not long ago by the Federal Communications Commission. Among its features are the facts that the receiver is of the superheterodyne type, that the frequency of the mobile transmitter is crystal controlled and its operation automatically controlled by the voice, and that it employs a vertical antenna in the form of a flexible steel rod for both transmitting and receiving.

THE receiver is constantly ready for operation so that messages from headquarters will at all times come in over the loudspeaker. The patrolman's ears and nerves are spared by a special circuit which causes the loudspeaker to remain silent unless the transmitter at headquarters is on the air.

To conserve power, the power supply of the car's transmitter is ordinarily off. To talk from the car, the patrolman merely lifts a handset telephone from its hook on the instrument board, simultaneously flipping a switch which turns on the dynamotor that supplies the transmitter. During the conversation, the sound of his voice automatically puts the car's transmitter on the air; as soon as he ceases talking it automatically switches off.

This is accomplished by two relays. The first is actuated by currents generated by the speaker's voice. It, in turn, actuates a second relay which throws the antenna from the receiver to the transmitter, likewise applying plate power to the transmitter and disconnecting it from the receiver.

These relays are extremely fast and the initial transfer is practically instantaneous. In reverse action, however, the second relay is more slowly timed. Consequently it does not act during the interval between words but only when the speaker pauses at the end of a phrase or sentence. Instead of the automatic voice control, a "grip-switch" in the handset may be used to actuate the second relay.

The crystal, which holds the transmitter to within .025 percent of its assigned frequency, is one of the newly developed type requiring temperature control only below freezing. At this point a heater automatically goes into operation. The transmitter weighs only 20 pounds and is 11 by 7 by 6½ inches.

The system is at present in operation in Evansville, Indiana, and is being installed in Nashville, Tennessee.

THE SEVEN LEAGUE BOOTS

Telephoto Lenses are Versatile . . . Annihilate Space . . . Larger Images . . . Better Portraits

By JACOB DESCHIN

"IF I were only nearer!" is a familiar thought to every camera user who has stood a hundred feet away from a "whopper" and sighed for the power to annihilate the space between. With a telephoto lens, you *are* nearer.

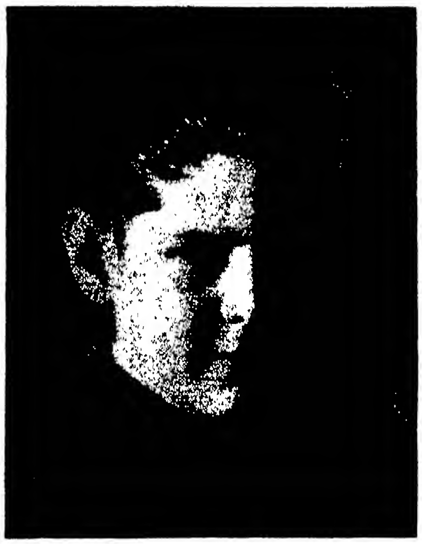
With a telephoto lens you are near an object in the street while stationed in a skyscraper, or near to the top of a skyscraper while stationed in the street; you are near—at distances which would be impractical with a lens of ordinary focal length—to the action at sports events, to what is going on across the street, to distant landscapes, to airplanes and birds winging across the sky, to animals some distance away, that would scamper away if you approached.

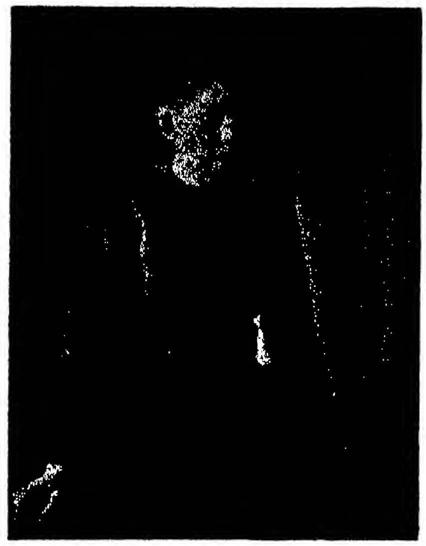
Everyone is familiar from childhood with the seven-league boots which magically carried the Puss-in-Boots of the classic fairy tale a full seven leagues forward each time she took a step, but modern telephoto lenses are more convenient still, for the cameraman has but to point his lens and the seven leagues vanish before his very eyes.

Vacation days are great days for the telephoto—in camp, in the mountains, at the seashore. High divers, with their graceful flight through the air from springboard to water, children at play in the sand, bathers splashing about in the surf, mountain climbers making their laborious way toward the heights, the many incidents in camp, are all grist for the telephotographic mill. The special virtue of telephotography in these and similar instances is that while some of the pictures can easily be taken with the ordinary lens, the latter will often include much more than is actually wanted, while the telephoto will more nearly limit the picture area to the subject desired, besides giving a larger image.

e bird is unaware of the photographer who some distance away, using a telephoto lens

This capacity of the telephoto lens to snuff out space and so give "close-up" images of distant objectives will suggest many possibilities for its use to the worker who has hitherto used only the regular lens on his camera. He can easily recall the many occasions when he would have given much to have been able to photograph a large image of an objective which he was forced to abandon because of the inability of his lens to do the trick.





Two portraits, both made at a distance of six feet. *Above:* With a 50-millimeter lens. *Left:* With a lens of 135-millimeter focal length

How many times, for example, has he longed to take "head and shoulder" portraits and found that he either could not get close enough or when he did that his subject's face was distorted due to poor perspective resulting from a too near view-point? Since in portraiture the face is *the* picture, a negative that shows only the head and the shoulders is often greatly to be preferred to the "three-quarter" or "full-length" picture. Compare a picture in which the face fills the negative with one containing the distractions of the subject's hands, dress, and other details, and the advantage of using a telephoto lens in portrait work will instantly become apparent. Facial studies of babies, children, the men and women among one's family and friends, "characters" about town, are always fascinating.

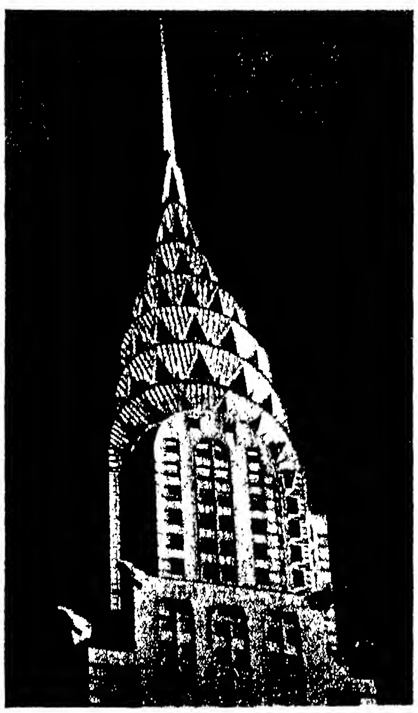
THE photography of distant landscapes is one of the favorite types of telephoto work. Here, except on extremely clear days, the cameraman must take into account the problem of atmospheric haze which is often encountered because of the great expanse of space through which the lens must cut its way to record a picture of the distant scene. In such cases it is necessary to use a yellow or light red filter, although panchromatic film must be used with the latter since orthochromatic film is practically insensitive to red.

Animal and nature photography is another splendid field for the telephoto enthusiast. Squirrels feeding from a child's hand or digging holes to bury their peanut hoard in anticipation of winter; pigeons, swallows, and other birds of the city parks in various amusing situations; swans and ducks pro-

OF PHOTOGRAPHY

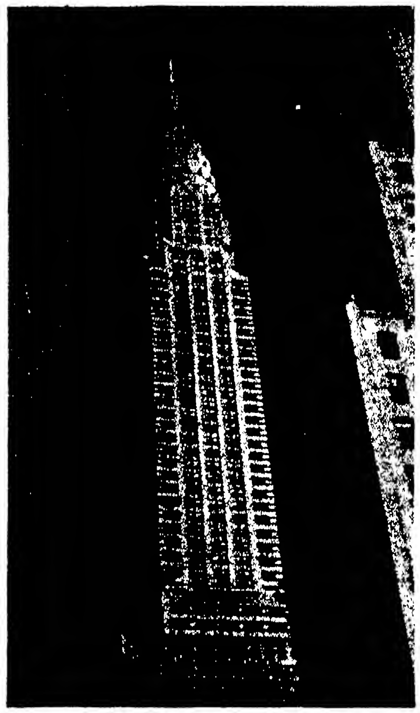
ceeding majestically over the smooth waters of the park pond; cats and dogs; the traffic policeman's horse feeding on sugar cubes from a pretty lady's hand; a monkey cavorting in a pet dealer's window—these are but a few of the opportunities open to the telephoto lens, and a search through woodland and forest for interesting plants, inviting paths, and other attractions of nature will provide many more.

Telephoto lenses are available for cameras ranging in size and bulk all the way from the large view cameras down to the miniature type. It is in the latter and the reflex camera classes, however,



that telephoto lenses have found their greatest popularity. The extra lens is carried in a case in one's coat pocket and when the need arises the regular lens of the camera is removed and the telephoto inserted in its place, the lens thereafter being used in the same manner as when employing the regular lens, the only difference being that objects are brought nearer.

Telephoto lenses are made in a variety of focal lengths, so that there is a wide choice varying all the way from a focal length of 3 inches in the case of fast miniature camera lenses, which give a magnification about 50 percent greater than the regularly employed 2-inch lens, to lenses which give a magnification of a dozen times and even much more. One



Photographs of a building, taken from the same distance. *Above:* Ordinary lens. *Left:* Telephoto

telephoto lens which will answer the worker's average needs will be sufficient for the start, but later on he may find that in certain instances this lens gives him a larger image than he wishes or is still too short for some phases of the work he does. For the larger reflex and view cameras there are available lenses which may be adjusted for different magnifications. A worker equipped with two or three telephoto lenses besides his regular lens should be in a position to tackle practically any problem that comes his way.

These extra lenses should individually be given every care, for the lens surface, being softer than that of ordinary glass, is easily scratched. A cap for both front and back of the lens should always be in place when the lens is not being used and each lens should be in its own case. When changing lenses even the most extravagant precautions will not be out of place. Beware of dirt, dust, or sand entering the camera, for these can do untold harm, particularly in their effect on the workings of the focal plane shutter of the miniature camera. Where possible, it is advisable to go indoors to change lenses and thus avoid dust and dirt and in addition effect the exchange of the lenses with more convenience.

While cameras equipped with tele-

Action photographs, otherwise unattainable, a often possible with a long focus telephoto le

photo lenses are generally placed on tripods or other steady support, there are many occasions when a snapshot while holding the camera in the hand is desirable, as in street or animal photography. When a telephoto-equipped camera is held in the hand, shutter speeds should be not slower than about 1/50th of a second to avoid vibration, which on a telephoto is greatly magnified. Wherever possible assist steadiness by bolstering your back against some firm support, such as a building, telegraph post, a tree or a fence, and, without straining, hold the camera absolutely steady. In miniature camera work, owing to the length and weight of the longer telephoto lenses, the technique is to grasp the camera in one hand and support the lens with the other, somewhat after the manner of holding a rifle. One further precaution: Always use a lens shade.

THE worker who is just acquiring a telephoto lens for the first time will soon discover to his delight that what he really has bought is the equivalent of a second camera, and the many possibilities which his new acquisition will open up to him will in the long run repay him handsomely for the cost of the lens in the pleasures he derives in photographing such distinctly telephotographic subjects as scenic views, portraits, and animals in park, street, and woodland.

The telephoto lens, in a hundred different ways, to which new ones are constantly being added by enthusiastic workers with such equipment, reveals a wonderful versatility and takes an honored place in photography as the cameraman's "open sesame" to the conquest of new photographic worlds.

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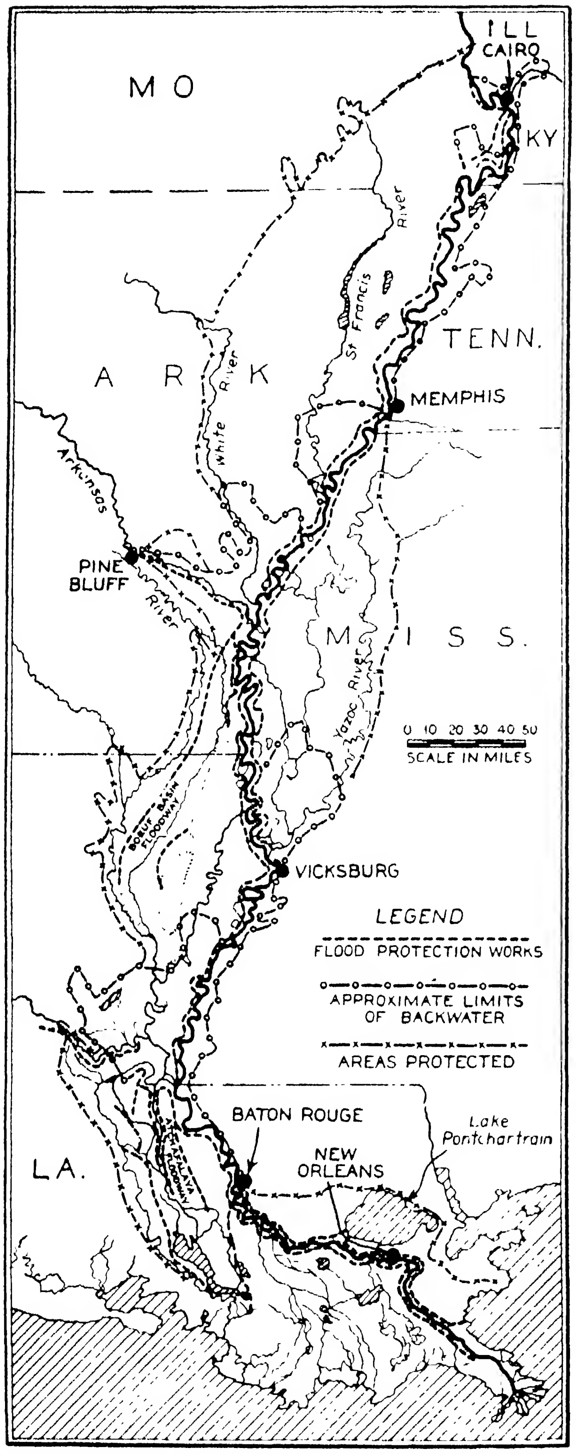
Starting next month: A regular monthly department devoted to all phases of photography of interest to the advanced amateur.



Flood control on lower Mississippi as planned and worked out by the United States Army Engineers

Flood Control

By R. G. SKERRETT

FLOOD-CONTROL work that has been going forward rapidly on the lower Mississippi River since 1928 has reached such a present stage that there is every reason to believe that this really stupendous project will be completed sometime in the first half of 1936. When that climax is reached, a total of 650,000,000 cubic yards of earth will have been placed in the defensive levees that have either been heightened or built entirely anew to hold within definite bounds the flood waters of the Mississippi River system seeking an outlet to the sea. This volume of earth is more than twice the amount of earth that had to be excavated in digging the Panama Canal.

To appreciate what has been planned and is being directed by the Corps of Engineers of the United States Army for the greater security of life and property in the region ravaged eight years ago, the general public should know something about the physical conditions contributing to the problem; about the magnitude of the factors that have to be taken into account, in providing a solution; and, finally, be told wherein the flood-control system now under construction differs from that heretofore relied upon throughout that stretch of the river.

WHAT is generally known as the Lower Mississippi River is that part of the "Father of Waters" that has cut a devious and changing course through a great alluvial valley that extends from Cape Girardeau, Missouri, southward to the Gulf of Mexico—an air-line distance of about 600 miles. The winding river, however, has a channel-way nearly 1100 miles long within the limits mentioned. The meandering course traced through the alluvial valley bed, the tremendous amount of silt carried by the river, and the large vertical range of surface level between mean low water and mean high water, add immensely to the difficulties that have to be mastered in restraining the river when in flood.

The drainage basin of the Mississippi River system extends from above the Canadian boundary southward to the Gulf of Mexico. Its eastward limit is within 250 miles of the Atlantic seaboard. On the west it reaches to within 500 miles of the Pacific Coast. In short, the Mississippi River and its tributaries draw from a watershed that has a total area of approximately 1,250,000 square miles. The volume of water moving seaward at any time is dependent upon the rainfall throughout this vast expanse as well as upon the season of the year; but, when a large percentage of the runoff is free to flow into the main stem of the system, the discharge into the Gulf of Mexico may be as much as 2,850,000 cubic feet per second! All this water escapes by what is, in effect, the small end of a funnel where the velocity of flow is highest because of the constricted area of the passageway.

Since De Soto's expedition saw the Mississippi in flood close to 400 years ago, when the lower river had a temporary width of 40 leagues, there have been fairly continuous records of the recurrent prevalence of similar stages of overflowing high water; and it is a fact established by these data that severe floods occur in the lower Mississippi on an average of every 2.8 years. It is not necessary for heavy precipitation to occur throughout the whole of the drainage basin in order to bring about a flood of major proportions. The unprecedentedly great flood of 1927 was principally the result of precipitation that was confined to the areas contiguous to the lower river while the season favored the rapid movement of the runoff into the tributary streams.

BEFORE the French founded New Orleans in the first quarter of the 18th Century and built a low levee along the riverside to protect the city from periodical floods, there is no evidence that elsewhere along the lower river earlier man reared any other barriers to hold such waters at bay. Prior to that time, the flood plain of the alluvial valley had an expanse of quite 30,000 square miles; and that basin offered the river a safety valve for the release of its seasonal overabundance as the flood moved in a comparatively leisurely way toward the several outlets by which the water journeyed to the sea. In the 200 and more years between the founding of New Orleans and the flood of 1927, levees were built along the banks of the lower Mississippi system until about 21,000 square miles of the basin became protected in this manner from flood waters—at least, that was the purpose for which those dikes were erected. Therefore man, in his efforts to cultivate and otherwise to utilize the rich soil of that region, shut out the river from the far-flung flood reservoir which it had

ON OL' MAN RIVER

Started 1928 . . . Completion Next Year . . . Levees Raised . . . "Fuse-Plug" Spillways . . . Floodways Provided . . . 650,000,000 Cubic Yards of Earth Moved

used for untold centuries. Just in proportion as the flanking levees interfered with the natural expanding of the river laterally, the volume of the water in any given interval of time rose higher and moved faster in its irresistible descent to the sea. The rushing waters, incidentally, became more destructively erosive as their turbulence and velocity increased. Decade by decade, some of the levees have had to be built higher and higher so that they would not be overtopped by the river at the crest of a flood. The normal range between mean low water and mean high water in sections of the lower river is as much as 40-odd feet. This was not the case when the river was free to occupy 20,000 square miles or more of its ancient flood plain.

SINCE the creation of the Mississippi River Commission in 1879, the system of levees along the lower Mississippi has been continually extended until it measures approximately 1900 miles—twice what it was in 1880. This method of keeping or trying to keep the river within bounds, for the convenience and safety of dwellers in the region, was adopted by the Government engineers because for fully 4000 years levee systems had proved to be the only means which alone could be used to solve a major flood-control problem. But effective as levees are in many respects, they are not a cure-all for flood evils. Time and again the levees of the lower Mississippi have been breached by flood waters, and extensive areas have been inundated as the river battled for its ancient elbow room. The engineer's answer to each of these irruptions has been either the broadening or strengthening of each damaged levee or raising it to a greater height. In this manner, the system generally has mounted successively, and as each new level was reached, the belief was fostered that the system as a whole was high enough and strong enough to meet any likely maximum flood stage. We know, however, that it failed at critical places when the river rose to the height it did eight years ago. Those facts, combined with a very critical analysis of all available data, led the Army engineers to plan the flood-control works that are now nearing completion—works that are to provide a margin of safety even should the flood waters attain the stupendous flow of 3,000,000 cubic feet a second!

In providing for this possible contingency, the crests of the primary system of levees are being raised three feet higher than they were in 1927; but the responsible experts are no longer placing entire dependence upon levees to hedge in flood waters. Instead, profiting by a lesson that should have been learned long ago, the engineers are offering to the river side channels of relief in the very region the stream occupied freely in centuries gone by. These side channels, or floodways, will detour the excess water above a given flood level, while the main levees will guide the major volume of the total flow safely onward to the sea.

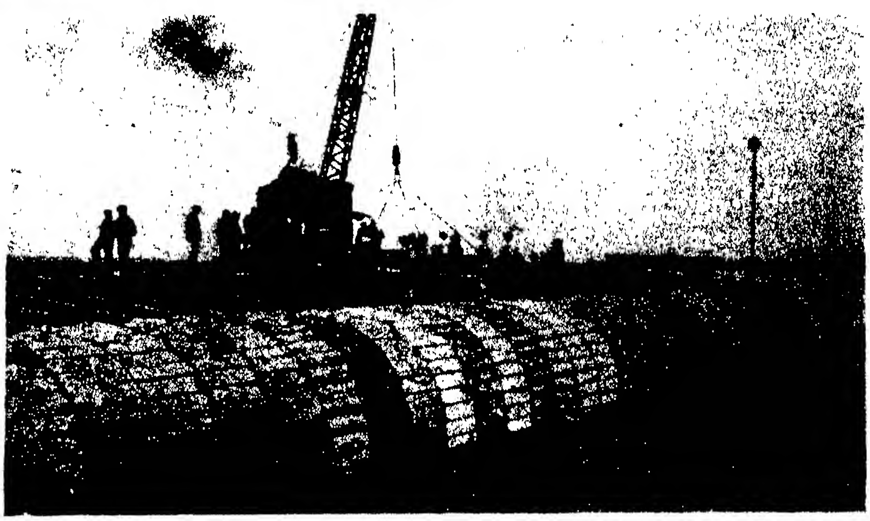
The more capacious of the floodways are to the westward of the customary course of the Mississippi, and only two of the new floodways are on the east side of the river. The western floodways are flanked on their western limits by a secondary line of comparatively low levees that will keep the detoured waters within circumscribed bounds and generally away from the more valuable lands of the region. The floodways west of the river are located in areas where farming is not extensive, and where occasional inundations will entail comparatively moderate crop losses. When flooded, those lands will probably be enriched by the silt deposited upon them. The broad plan of flood protection represents a carefully thought-out compromise that makes certain reasonable concessions to the ancient natural rights of the "Father of Waters" and to the rights that intrusive man has acquired by settling in the region and by developing it for his own ends.

IN prehistoric times, the Mississippi River had numerous outlets to the Gulf of Mexico which were in certain cases safety valves during flood stages, while some of them carried off water more or less continuously. The early explorers and settlers found that the river discharged into various bayous—to the east and west of the present navigable channel—that have since become closed. One such by-pass, on the east, connected with Lake Pontchartrain. The Atchafalaya River, on the west, functioned then as now as an all-stage supplemental channel, and the existing flood-control plan provides for the use of the Atchafalaya and some of the low-lying territory traversed by it for a floodway. The Bonnet Carré spillway, on the east bank of the river about 40 miles above New Orleans and recently completed, will permit flood water, above a given level, to flow into Lake Pontchartrain and thus reach the Gulf of Mexico.

Upstream of Vicksburg, Mississippi, adjacent to the confluence of the Mississippi and the Yazoo Rivers, there is also created a backwater area of floodway which, as a flood subsides, will gradually return the water into the main channel. Three other backwater reservoirs on the west side of the Mississippi system in Arkansas and Louisiana will be able to accommodate temporarily excess flood waters and then feed them back into the

Great dragline excavators digging earth and depositing it on the levee in the center. More than 3,000,000 cubic yards of earth will go into the finished flood barrier in the Atchafalaya section, thus making it an enormous lateral dam

Scarcity of stone and a plentiful supply of sand and gravel along the lower Mississippi have led to the use of cast concrete tetrahedrons for building revetments. Their shape prevents tumbling by swirling waters, so they have proved effective in retarding erosion of the soil



Launching articulated concrete mattresses, a highly satisfactory form of revetment, from a barge on which they are cast continuously

main stream as the flood level drops. The inundation of several of these floodways will be through or over "fuse-plug" levees placed at strategic positions. The crest of each of these spillways is three feet lower than the crest of the adjoining main levee, and the passageway thus offered is broad enough for an enormous volume of water to escape while still leaving the crest of the main levee a full foot higher than the surface of the flood. Should the flood level persist, the escaping waters will wear down or breach the fuse-plug levee and allow still more water to flow into the floodway and thus relieve pressure upon the main levees. The defensive barriers are counted upon to protect 12,000,000 acres from overtopping waters; and the floodways and the backwater areas will, together, provide emergency relief basins having a total expanse of 8,000,000 acres.

The levees range in height from about 20 feet to more than 30 feet, and are massive ridges of earth arranged generally parallel with the riversides, and broad enough in cross section to stand against the pressure exerted upon their river slopes by flood waters. The earth required for their construction is uniformly excavated from borrow pits in the vicinity of the levees, but far enough to the rear not to induce undermining by water moving through the ground upon which the levees are reared. Because of this requirement, especially in low ground near the edges of the river, it is sometimes necessary to go inland several hundred yards to dig the dirt for levees, and the different circumstances of the source of the essential material have called for the development of novel and diversified mechanical means for excavating and transporting the earth. Government experts and the contractors have contributed to this development work, and construction has proceeded uninterruptedly and with such success that the entire project will be finished long before the date originally set.

The Mississippi's swirling, swiftly moving flood waters are highly erosive, undermine river banks, and damage riverside properties. The materials so detached are redeposited where they may change the course of the river and possibly obstruct navigable channels. Therefore, flood control and the maintenance of channels are inter-related activities, and this is especially so in providing protection of the banks against erosion. Again, the responsible officers of the Corps of Engineers have devised numerous forms of revetments either to deflect the river currents or to blanket the banks from above the high-water line on the shore outward for some distance below the surface of the river at low water. In some cases, these mattresses are made up of fagoted masses of willow branches 16 inches thick and laced together to form a unit mattress 150 feet long and 100 feet wide, several of these rectangular sections being spliced together to form a single great mattress 200 feet wide and from 300 to 1000 feet long. The mattress is held in place upon the bank and river bed by rock ballast dumped upon it.

A LATER and more rugged form of revetment is that of slabs or blocks of reinforced concrete linked together by flexible metal bonds. A mattress of this sort is constructed in successive sections on barges equipped for the purpose. The shore end is hauled up as high as desired on the bared bank and then added to, strip by strip, and extended as far as needed underwater toward the center of the stream. The very latest type of mattress consists of a reinforcement fashioned of wire cables and steel mesh embedded in a heavy sheet of asphalt paving. With the floating plant devised for the work, a flexible blanket of this sort three inches thick, 200 feet in width, and more than 500 feet in length can be fabricated at a rate of 30 linear feet an hour. A mattress of this kind, laid upon the bank and bottom of the river, will effectually protect the underlying ground from the erosive sweep of the swift waters; and, because of the enduring character of the asphalt, the mattress will probably last unimpaired for many years.

The estimated ultimate cost of this flood-control work is 325,000,000 dollars; and of this amount 257,000,000 dollars have been either expended or appropriated to carry on the undertaking. This money is being provided by the Federal Government; and local interests have not contributed. In addition to giving protection to the alluvial valley, the project will increase the value of property in the region and promote the welfare and prosperity of everyone living there—incidentally having a beneficial reflex on the nation as a whole. At this time, the undertaking has been carried forward far enough to protect the lower valley against all but the greater floods; and there is every reason to believe that the full program of flood-control work will be finished well within the 10 years originally set in 1928. In its various aspects, the project is an engineering task of truly monumental proportions.

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The author of this article, Mr. Skerrett, has written another interesting engineering article concerning unique construction methods used on a bridge in Denmark. It will be published soon. —The Editor.

Office Efficiency

Increased by Scientific Study . . . Better Light... Quiet... Comfort... How Studied

By DEAN M. WARREN

IT is axiomatic that efficiency in work of any kind is highest when employees have comfortable working conditions. Lighting also is known to play an important part. With these facts in mind, A. H. Stricker and M. W. Ulf of General Electric's Nela Park plant set about to lessen the fatigue of their card punch operators.

The first step was to design and install for each a more convenient shelf to hold the papers from which they transcribed. The second was to add a supplementary lighting system to the one already installed which delivered about 8 footcandles on the working area. These two changes increased operator efficiency. Production increased 30 percent while errors, always low, were decreased 27 percent. Then unnecessary noises were reduced by carpeting the floors and relocating the supervisor's desk. The changes so far had eliminated factors which caused physical tension and bodily fatigue so the investigators began a restudy of earlier changes.

NEXT to be reviewed was the lighting, and here a major improvement was made. The original auxiliary system consisted of a small bowl reflector equipped with a 25-watt lamp and adjustable to any desired position by means of a flexible arm. It had many shortcomings. It gave only a spot of light on the paper and also was objectionable from the standpoint of reflected glare. After much experimenting, and with the consulting assistance of the Engineering Department, a supplementary lighting system that consisted of an adaptation of the Illuminating Engineering Society's study lamp was installed.

Fatigue of office workers measured by the ophthalmic ergograph

In order to discover to what extent the additional footcandles actually reduced fatigue, tests were given the operators by engineers. One day a group of operators would work under the general lighting alone, while another group worked under the supplementary system; the following day they would alternate. Tests were made at the beginning and end of the day by means of a semi-automatic ophthalmic ergograph for measuring ocular fatigue. This instrument consists of a pair of prisms that rotate in opposite directions. The subject places her right eye at the prism, keeping both eyes open, and fixates upon the test object, a small capital E, 14 inches from the observer. When the subject is comfortably positioned, she opens an electrical circuit by means of a key which brings into play a magnetic clutch and rotates the prisms. When the power of the prism overcomes the converging power of the eyes, the image splits into two, one for each eye. At the instant of splitting, the subject depresses the key, returning the prisms to zero position, ready for the next observation. This was repeated twenty times to obtain an average. These tests indicated that the eye muscles were three times as fatigued when the day's work was done under the lower levels of illumination as they were when it was done under the higher levels.

This study in office efficiency is significant because of the fact that there are many thousands of power-driven machines in use throughout the country today on which similar tests could be made in the interests of increased efficiency and greater production.

***Below:* The card punch operators working under difficult conditions of lighting and inconvenient work placement**

The improved set-up, with individual lights that do not produce glare. Newly designed brackets hold the sheets

Sun Clocks

Beautiful Garden Ornaments . . . Sun Clocks, Not Sundials . . . Dependable to Within One Minute

By RUSSELL W. PORTER
Associate in Optics and Instrument Design at the California Institute of Technology. Contributing Editor

Illustrations by the author

THE advent of the pendulum clock gave the sundial a knockout blow as a time keeper, for it was independent of the weather, and indicated the passing of the hours whether the sun was shining or not. And of course nowadays, if the old clock runs down, we pick up the right time to the second by switching on the radio.

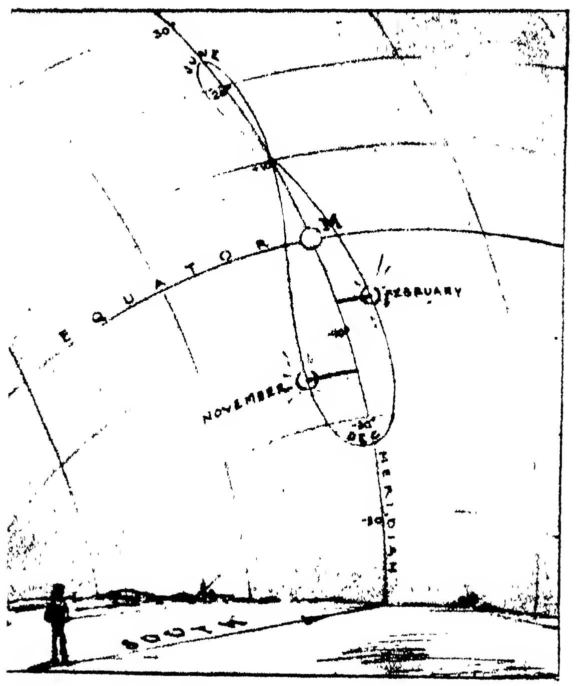


Figure 1: **The master analemma is the one which is traced on the sky by the real sun's changes**

However, the sundial is still a charming garden ornament, even if one has to perform a mental calculation to use it though even then there is an uncertainty of a few minutes, due to the ill-defined shadow cast by the gnomon. Some years ago (August, 1928) the SCIENTIFIC AMERICAN published an article of mine in which I attempted to give more precision to the sundial by forming, with a lens, a sharp image of the sun, instead of using the shadow above referred to. These experiments led me into using the sun's image, in connection with the familiar clock face carrying the hour and minute hands, an advance in dialling originally due to W. E. Cooke, of Australia. Furthermore, to avoid the mental addition or subtraction already mentioned, I have drawn on the properties of the analemma, that odd looking hourglass figure so often seen on globes, with the ultimate object of so tying up the lens, analemma and clock dial, that standard watch time is found directly. No discovery is claimed for using this combination, the general idea having been known for years, but the manner of employing these various elements in beautiful garden ornaments may be found interesting.

The trouble with Old Sol as a steady timekeeper is that he does not arrive due south of us every day exactly at noon (by our watch). Depending on the season, he is either ahead of or behind time. But our clocks will not run fast and slow to accommodate our luminary—they must run at a uniform rate. Moreover, we desire our days to be of the same length—24 hours. And so the astronomers hit upon the device of imagining a fictitious sun that came around to the meridian at 24-hour intervals, and called it the "mean" sun, as distinguished from the real or "apparent" sun which we see. These two "suns" travel across the sky more or less in company, never more than 16 minutes of time apart.

In Figure 1, imagine yourself looking at the framework of the southern heavens—there you stand in the lower left-hand corner. Two examples are shown at random, in November and February, both when the fictitious sun M is on the meridian at high noon. But in the first case—November—the sun we actually see is lagging behind his companion M, and in the other—February—he has forged ahead. These separations, if plotted for the year, will yield the curved path shown—our analemma—and the interval separating the two suns (indicated by the heavy black lines in the drawing) is known as the "equation of time."

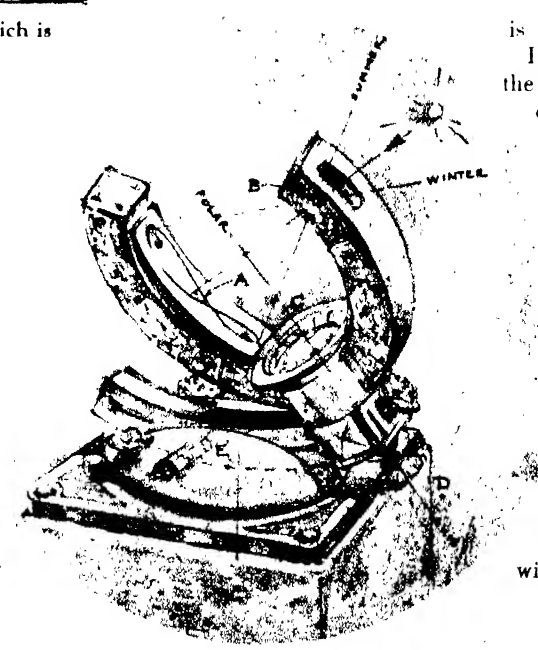


Figure 2 (below): **With hands but without works, the sun clock accurately tells the time**

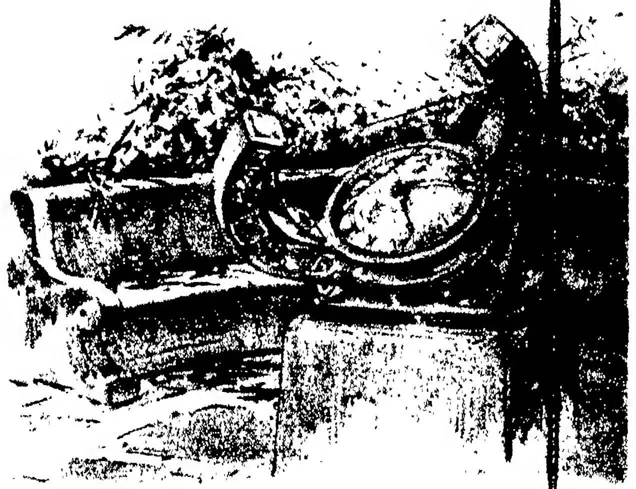


Figure 3: **This is similar to Figure 2, except that it has a different base and is actuated by means of a worm gear**

I think it is now fairly obvious why, in the sun clock, we let the sun's image fall on the analemma instead of on the meridian. Sketches accompanying this article are a few of those accumulated during the past ten years.

Figure 2 will give a good idea of the principle involved. **The analemma A is shown on a curved brass plate which has a radius of curvature equal to the focal length of the small lens B. The reason why we let the sun's image fall on this "figure eight," as already explained, is that in so doing we automatically get mean time instead of apparent time, as with the sundial.**

The clock face—there is no clock movement back of it, but just the hand and face—is shown at C, and the problem now is to so tie up the rotation of the analemma and lens with the hour and minute hands, by proper gearing, that when the apparatus is turned by hand, using the petal D, so that the sun's image from the lens bisects the figure eight, the clock hands will indicate the time. It is done by means of a simple gear train that turns the minute hand 24 times in a day, the hour hand two times a day, and the ring carrying the analemma and lens once a day. These are the three ratios, 24, 2 and 1, and all three of the corresponding parts are driven by turning the lower petal. Of course, you must know which wing of the figure eight to use in bisecting the sun's image, but the months are usually stamped on the analemma (clearly shown in Figure 6). In this design, provision is made for inclining the polar axis to fit the latitude, and clamping with setscrew E in Figure 2.

FIGURE 3 is similar to Figure 2, but has a permanent base A, and the drive is through the worm shaft B.

By introducing an additional reflection, with a right-angle prism, we can radically change the design, and view the sun's image by transmission, drawing the analemma on a piece of curved, translucent celluloid or ground glass. In Figure 4 the prism and lens are at A, and the reflected, converging beam is thrown up to the analemma, which covers the opening B, B. The upper bearing of the polar axle C rests on the two leaf pads D, D, and on the knurled head E. This carries the minute hand and has a pinion that engages the bent rack F. For careful setting purposes, the bent rack is quite as satisfactory as the more expensive worm wheel in Figure 3. Even when setting by hand, as in the case of the clock shown in Figure 5, the bisection is fairly easily made. But one can always set a division a little ahead of the sun's image and then watch the disk of light creep up until it is certain that the disk is bisected. The uncertainty is never more than a few seconds.

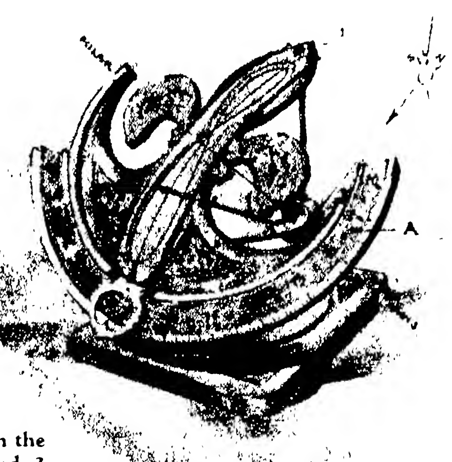


Figure 4: **Another change rung on the principle shown in Figures 2 and 3**

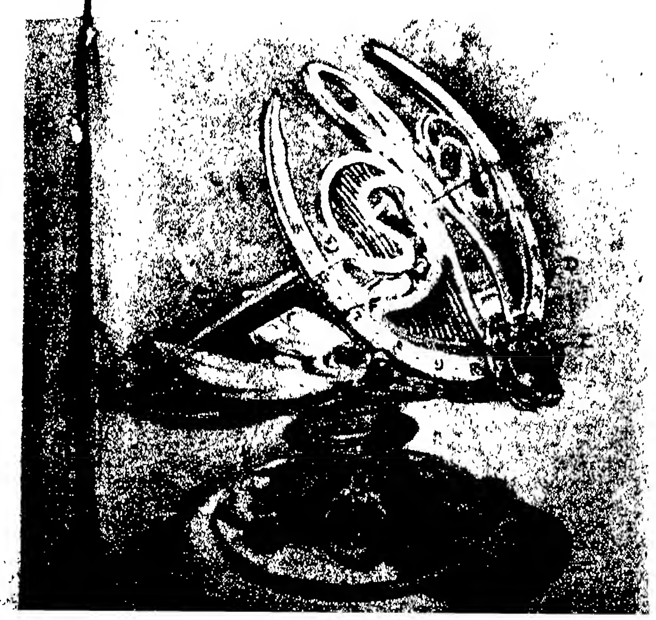


Figure 5: **Still another variation of the basic principles already stated**

A variant on this arrangement is shown in Figure 5. Here the polar axle, carrying the prism, lens, and analemma, slides in a groove around a fixed hour circle A. In these two designs, Figures 4 and 5, the analemma has been fitted into the conventional pattern of the fleur-de-lis.

In all of these attempts to get accurate watch time from the sun, I have experienced the most trouble in properly adjusting the polar axis of the instrument parallel with that of the earth. One satisfactory solution was found in the design shown in Figure 6, where the sun clock has been stripped of everything but bare essentials. Unfortunately the clock face is turned down, and has to be viewed through the looking glass A. **But the instrument can be adjusted and checked on Polaris any clear evening. To do this, the diagonal mirror B is removed and an image of Polaris is formed by the lens C, on the polished plate carrying the analemma. A line drawn from the center of the lens to any part of the small circle D, makes an angle with the polar axis equal to the complement of** Polaris' declination, viz. 1° 05′. The image of the star is readily picked up with a magnifying glass, and the adjustment made with proper allowance for hour angle. The diagonal is returned to its seat, and time to well within one minute may be depended upon.

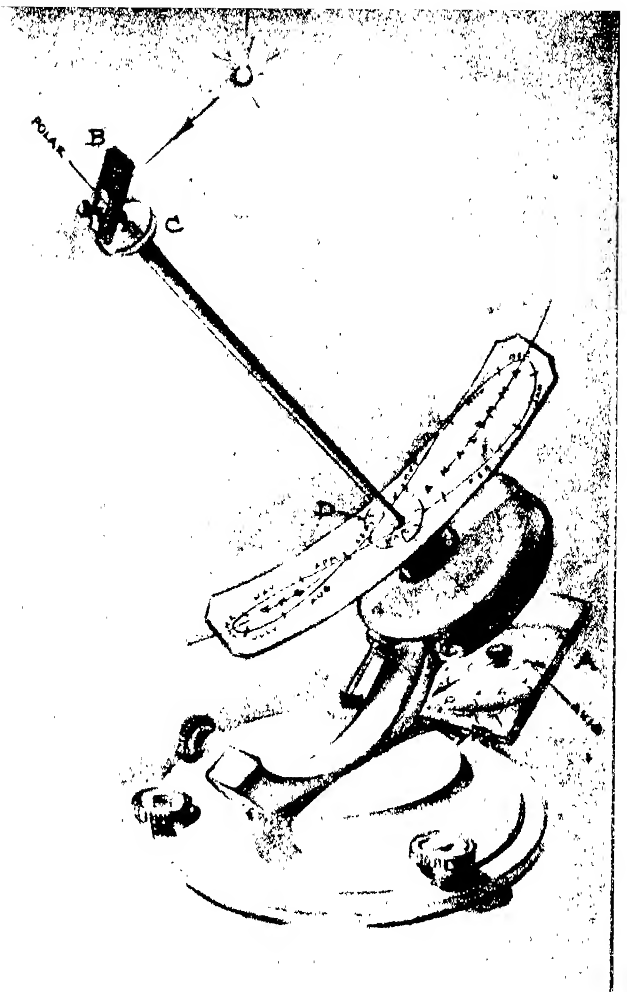


Figure 6: **This design is arranged to facilitate adjustment of the sun clock to parallelism with the axis of the earth**

It should be noted that, not only will the sun's image on the analemma give standard time, but it will also give the day of the month.

There is probably nothing to be gained in accuracy by increasing the focal length of the lens beyond eight or ten inches, which gives an image somewhat under an eighth of an inch in diameter. Neither should the lens aperture be over a quarter of an inch (f/40). On polished brass the image is very easy on the eyes if filtered through a wafer of red or yellow glass.

All parts of the sun clock should be of non-corrosive metal—brass, statuary bronze, rustless steel, aluminum, or some other.

Well, the sun clock may be little more than a novelty, since we are living in an age when time may be picked out of the ether whenever desired. But it's lots of fun, out here in California where there is almost too much sunshine (I come from New England), to rehabilitate the sundial into an instrument of precision, and to juggle its optics and watch the various forms develop.—*Pasadena, March, 1935.*

THE BLUE CLOUDS OF MARS

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

IT is doubtful whether anything else in the skies excites so widespread and general an interest as the planet Mars—unless indeed a total eclipse of the sun is imminent, or a great comet is in sight. There is sound reason for this, for we can find out enough about the planet to be sure that it is more or less similar to our own world, and yet not enough to be sure *how* similar—so that the questions most interesting to the imagination remain unsettled.

A first telescopic view of Mars—even with a large instrument and under good atmospheric conditions—is likely to be very disappointing to the novice; and the more familiar he is with the drawings, or even the photographs, made by professional students of the planet, the worse will be his disillusionment.

There is plenty of detail on the planet's surface, but it lacks contrast—an artist would describe it as being pitched in a very low key. It would not be fair to expect Mars to look like the moon at her quarter, when the jet black shadows and brilliantly lighted peaks make an exceedingly "snappy" picture. The full moon, when there are no shadows to bring out the relief of the surface, and only the tone and color of its materials count, is more fairly comparable. But her spotted face shows more contrast than the planet's, as is evident when the two are compared with such magnifying powers that they appear of the same angular dimensions. At its nearest, Mars appears to be 25″ in diameter. When at opposition, in the part of its orbit remotest from the sun, as it was recently, its apparent diameter is only 14″.

WITH a power of 300—which is moderate for planetary observation in good seeing—Mars, as seen through the telescope at the least favorable opposition, looks more than twice as big as the moon to the naked eye, and under the best conditions nearly four times as big. We might then expect to see as much on Mars with a telescope as on the full moon with a good opera glass, but we do not.

The greater part of the difference arises from atmospheric unsteadiness. To the unaided eye, and even with a good binocular held in a steady clamp, the images of heavenly bodies are steady (except for the sun at the point of setting). But when the disturbances are magnified some hundredfold they become very serious. It would be hard to match them in a naked-eye view, even by artificial means. One might do so by getting the moon directly over a chimney from which heated, though smokeless, gases were pouring, or maybe by lying on the floor and looking through an open window just above a radiator working at its fullest power.

Courtesy The Lick Observatory, and Publications of the Astronomical Society of the Pacific

Photographs of Mars, taken March 14, 1935, with a 12-inch refractor, at the Lick Observatory. In the ultra-violet (*left*) as is the case in the violet, light area at the bottom is the north polar cap (telescope inverts), but the south polar cap is turned away. Large clouds—three light areas (squint the eyes)—are seen between these. In the infra-red (the right-hand photograph) the clouds do not show, just as is the case with thin haze on earth. But two canals, too fine to reproduce, show on the original photograph, extending from the north polar cap into the brighter area. Dark area at bottom is Mare Acidalium

To see just how hard these conditions would have to be to spoil a view of the moon with the naked eye, or with an opera glass, might be an amusing experiment for an amateur astronomer already familiar with telescopic "bad seeing"—as, alas, all who look through telescopes must be.

In photographing Mars, unsteadiness is even a worse obstacle, for the eye can seize the moments when the images are good and the plate cannot. But the "flatness" of the picture can be greatly modified by the choice of suitable color filters. With the filter transmitting the deep red, the contrast of the surface markings is greatly enhanced. Such photographs, especially if printed on contrasty paper, make the details far more conspicuous than they ever appear to the eye. This is not, of course, a defect of the photographs but a great advantage; it brings out things which would otherwise be hardly observable—just as photography of star clusters and nebulae does to a much higher degree. With yellow or green light the gradation is much the same as to the eye. With a screen transmitting the violet only, the surface markings practically disappear—not because they are obscured by anything in front of them, but since the reddish and the greenish areas both photograph equally dark with light of this color.

Even under good visual observing conditions, or when photographing with appropriate color screens, the Martian details are sometimes difficult to make out. There are real seasonal changes: in the early spring of the planet's temperate regions the darker areas show less than the usual contrast, and parts of them may be hard to detect, while in late summer they are, in general, decidedly darker and more conspicuous. Some of the beautiful photographs obtained at the Lowell Observatory show these changes clearly, and afford an objective proof of their reality.

BUT there are more rapid changes in visibility, for which neither the earth's atmosphere nor the Martian seasons can be held responsible. There is at all times a whitish illumination at the planet's edge—called the limb-light—and as the rotation carries the markings into this, they are partly or wholly drowned out. The explanation of this is simple. When we are looking at the center of the disk, our line of sight passes almost squarely down to the surface and through but a small thickness of the planet's atmosphere. Near the apparent edge, the rays strike obliquely and traverse a much greater amount of the gases. Any haziness—even the small effect of scattering by the molecules, which is inevitably present in all gases—will therefore be greatly magnified near the limb and produce an effect of just the observed type.

The earth, viewed from without, would undoubtedly show a similar but much more conspicuous effect—as is obvious when one considers the character of the views steeply downward and off toward the horizon, from an airplane or a high mountain peak. At times the markings appear to be veiled over large areas, even near the middle of the disk. These effects usually last but a few days, and it is reasonable to attribute them to temporary fogs or haze. An observer on

the moon or Venus—could one exist there—would undoubtedly have noticed obscuration of this sort, and of remarkable persistence, over the central-western portions of the terrestrial marking which is known to us as North America!

Sometimes—though very much more rarely than on earth—definite clouds appear upon Mars, and completely obscure large areas with a whitish veil. Such formations are just unusual enough to deserve specific mention in astronomical literature. A conspicuous group of clouds which appeared on March 12 of the present year is illustrated on page 86, which shows photographs by Dr. Wright made at the Lick Observatory and reproduced by their courteous permission. These clouds were evidently bluish, for they are not visible on the right-hand photograph taken with infra-red light, but are very strong in the violet and ultra-violet (left-hand photograph)—so much so that they, as well as the polar caps, cause an apparent swelling of the photographic images, giving them their curious lumpy appearance. It is noteworthy that they are much more conspicuous toward the edges of the disk than near the center.

CLOUDS which were conspicuous when the sun rose over the Martian surface often partially fade out near noon. This behavior has often been recorded, and is obviously and simply interpretable. They form before sunrise, dissipate in the warmth of noon, and return in the cool of the evening. This is enough to settle that these markings are produced by some sort of condensation of atmospheric vapors. But they do not appear to be quite like our familiar clouds on earth. Everyone who has attempted cloud photography knows that the first prerequisite is a yellow or red screen. On an ordinary photograph the sky may be very "flat," but in the red the clouds stand out sharply against a dark background. This happens mainly because this background is the clear blue sky, which scatters the violet light powerfully and the red very little. But we would not get the pictures that we do, unless the clouds themselves reflected all colors of light almost equally well (as their whiteness proves to the eye). Clouds as white as ours would undoubtedly show on infra-red pictures—even if taken from above—against the darker background of a planet's surface. Hence these Martian clouds must not be pure white, but bluish—banks of blue haze, rather than dense fog.

Is this reasonable? We may meet the question with another: What are the clouds on Mars made of, anyhow? We can be sure of one thing: it is the same stuff which forms the polar caps. Ever since the regular seasonal changes of the latter were observed, nearly three centuries ago, it has been generally recognized that they must be composed of something snow-like. This melts or evaporates in the spring and summer, "vanishing into the air," and comes down not long afterward in the opposite winter hemisphere, after a long journey which it can only have in the form of invisible vapor. But there are a great many substances which are equally capable of doing this. Water—frozen into snow—will fully meet the conditions. So also would carbon dioxide condensed

Courtesy Lick Observatory

The ordinary (cloudless) photographic appearance of Mars. Taken in 1924. *Left:* In the ultra-violet. Note south polar cap. *Center:* In the yellow. The markings show faintly. *Right:* In the infra-red the dark markings, Syrtis Major at left limb, Sinus Sabaeus in center, Margaritifer Sinus and Indus to the right, show up the best. Many astronomers now agree that these are vegetation, for they exhibit seasonal changes in color and intensity, and that the rest is desert. The center picture is more like the kind of seeing we get visually, being fainter. Unless the observer knows what to look for, he will see little on Mars even if the seeing is good. It is a matter of training, not of the eye but very largely of the brain

into the solid form now familiar to us all as "dry ice"—and so would sulfur dioxide or ammonia.

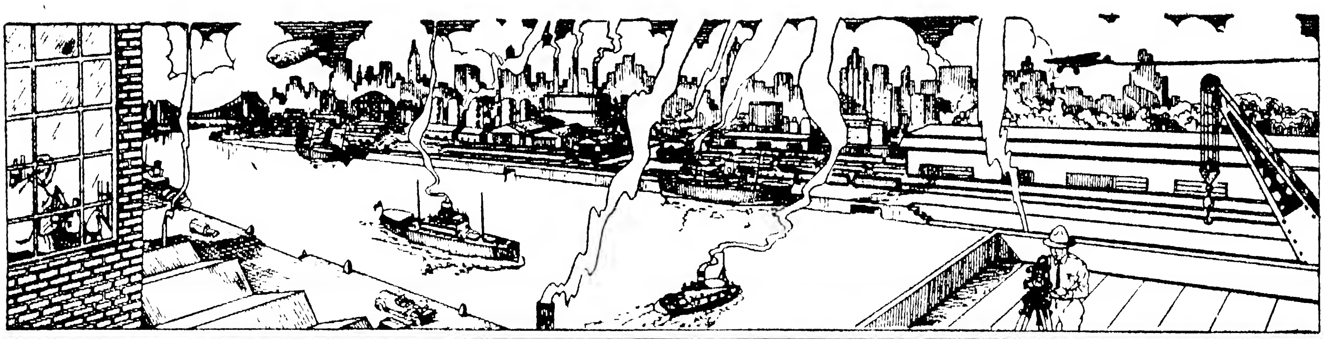
Mere telescopic observation, however careful, cannot distinguish between them. It tells us one thing, however. The retreat of the shrinking caps has been carefully observed, and is found to occur with remarkable regularity, year after year. The date when any particular spot on the surface gets clear (measured in a Martian calendar) shifts but a very few days from one year to another—it is incomparably more regular than that of the first or last snowfall here. Moreover, this date in different latitudes comes always at the time when the returning rays of the sun carry a certain definite amount of heat to the surface. Mars is nearest the sun in the summer of its southern hemisphere—and the time schedule for the shrinking of the southern cap is shifted accordingly, coming earlier in the springtime in the north, but corresponding to the same daily supply of solar heat.

This shows clearly that the polar caps are composed of some one substance which disappears just as soon as the surface reaches a definite temperature. Now this temperature can be calculated, for we know how much heat the surface gets from the sun, and can safely assume that its radiating power is much like that of terrestrial rocks or clays. The results are conclusive. Though the computed temperature is well below the freezing point of water, it is so far above the boiling points of the other substances mentioned (or the temperature of sublimation of carbon dioxide, which at low pressures passes directly from a solid into a gas) that they are quite put out of further consideration, and only water remains.

The caps are of course composed, not of liquid matter, but of some form of snow or hoar-frost. In sufficiently dry air, snow will evaporate and disappear without melting, at a temperature below the freezing point. This has often been observed in the Northwest; indeed, it used to be a commonplace in the old days for a housewife to hang out her washing on the line, only to have the clothes freeze as hard as boards almost before the clothespins were on. After a day or two, with clear freezing weather all the time, the clothes would be perfectly dry. The ice had not been beaten out by flapping in the wind; it had evaporated into the dry air. Something of this sort evidently happens in the polar regions of Mars every spring.

AIR as cold as this is saturated by a very small quantity of water vapor. This suffices to explain what might otherwise be puzzling—that the spectroscopic tests show no definite evidence of water vapor in the atmosphere of Mars. Were the temperature high, and the corresponding tension of water vapor great, we might expect to get observable absorption, despite the difficulties caused by the water vapor in our own atmosphere through which we have to look. But an atmosphere as cold as that near the polar cap must at best be very dry, and the feeble absorption produced within it might easily be masked by the overlying terrestrial lines, even though the most powerful means of separation available to us should be tried.

The equatorial regions of Mars, in which the winds blowing from the poles have been warmed, must be at least as dry, and it is possible that liquid water could hardly exist there at all without immediate evaporation. Condensation into the dense masses of cloud which occur in the moisture-laden atmosphere of the earth would be very unlikely. Under the most favorable conditions we might expect the production of very thin clouds of ice crystals, not of water drops like our own high-level clouds. If the particles were fine enough, such clouds would scatter blue light more powerfully than red, and would appear as bluish haze rather than as dense white masses—and this is very probably the nature of the fugitive markings which have recently been observed.—*Princeton University Observatory, May 8, 1935.*



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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Living Test Tubes

An important biological experiment, which has puzzled scientists for more than 50 years and may lead eventually to the isolation of the germs which cause colds, influenza, and infantile paralysis, has been successfully completed at the University of Notre Dame. After six years of constant laboratory work, Prof. J. A. Reyniers has succeeded in obtaining absolutely germ-free guinea pigs and in raising them without contamination by germ-life of any kind.

Professor Reyniers examining his living test tubes through a glass port-hole in the chamber described in the text. His arms are encased in rubber gloves sealed in two ports

The importance of this work lies in the fact that it permits a study of any single germ on a living organism, until now considered impossible. Most scientists hitherto have contended that life in an animal body was impossible without bacteria.

Moreover, it was this presence of many forms of germ life which has interfered seriously with the isolation in the past of the germs which cause many of the most current human ailments and, consequently, no serums or other effective preventives have yet been developed.

The compartment in which the pigs live, and which contains all the attendant apparatus, including the air-conditioning equipment, resembles a square diving bell, with portholes in each side to permit inspection of the germ-free inhabitants.

In addition, there are two ports, containing sterilized rubber gloves, through which Prof. Reyniers can insert his hands to care for his charges, clean the cages, fill the milk and water bottles, and examine the pigs periodically for any sign of contamination.

Longer Life for Silk Stockings

Ladies, here's a practical tip from Uncle Sam on how to make silk stockings last longer! According to chemists at the Bureau of Standards, tests reveal the fact that aluminum sulfate can be used as an excellent preservative for silk stockings. The treatment, which is claimed to considerably increase the strength of the materials, consists of dipping new stockings in a hot solution of about 3 percent aluminum sulfate. After the treatment the stockings should be dried and then washed gently.—*A. E. B.*

U. S. Excels in Wasting Soils

"The most colossal achievement in soil wastage the world has ever witnessed in as short a time" is the way in which H. H. Bennett, of the Soil Erosion Service, United States Department of Agriculture, characterizes soil erosion losses in this country. "Although three centuries have passed since the first successful colonization, much of our ruined land has known the plow for scarcely more than a generation."

A nation-wide survey by the Soil Erosion Service shows that approximately 50 million acres of once fertile land have been ruined for practical crop use by erosion, with another 50 million acres in almost as bad condition. This 100 million acres is equal to 625,000 farms of 160 acres each.

Another 125 million acres, says Mr. Bennett, most of it still under cultivation, have

Courtesy *The Reclamation Era*

After admiring this photograph of the Arizona hills mirrored in the lake forming above Boulder Dam, do not fail to turn the magazine sidewise (either way) and see the faces, austere and gruesome, that peer at you. These countenances were first called to attention by Dr. William F. Durand, Stanford University, Consulting Engineer of the Bureau of Reclamation, Department of the Interior

lost all or most of the topsoil; on other millions of acres erosion is getting under way, so that good farm land is being destroyed at the rate of more than 100,000 acres a year.

"The world is strewn with ruins of once flourishing civilizations destroyed by erosion, particularly in Syria, Turkey, and China, but these lands were cultivated for thousands of years before abandonment was necessary."

ANCIENT PLASTIC

KING Tut's sarcophagus was varnished with melted amber. This long prized material is giving way in modern days to the synthetic plastics which have become a large industry.

PROGRESS In This Age Of Science

As Told to SCIENTIFIC AMERICAN

By EDWARD G. BUDD
President,
Edward G. Budd Manufacturing Company

MOST of the work done in this world is in moving things around.

A tree trunk is hauled to the saw mill, planks are moved from the saw mill to the lumber yard, then from the lumber yard to the factory, and from one part of the factory to another part on trucks or elevators. The product is then moved to the furniture store and from the store to the buyer. The capable housekeeper keeps moving it around all the rest of its existence.

A great part of our life is spent in moving our bodies from one place to another. In most instances, vehicles are employed; usually the vehicle is vastly heavier than the goods moved.

The consumption or waste of human effort and mechanical power has in recent years been much reduced by improved types of motive power and by improved highways. In recent years the dead weight of the vehicle has rather increased than lessened.

There is now before us an era of weight reduction in carriers, whether ships, elevators, automobiles, or railways.

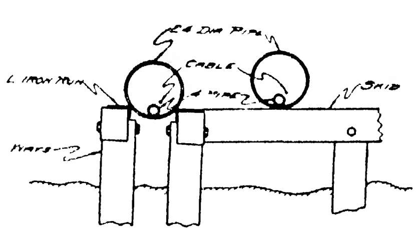
A contribution to the revival of business will be the production of railroad vehicles weighing from one half to one eighth of those now in existence, reducing the cost of carrying the persons or goods by one half to one quarter of the previous practice.

Developed in times of depression, this new art will be a powerful lever in economic rehabilitation.

SEWERAGE OUTFALL PIPE PUSHED INTO SEA

THERE have been a number of occasions when it was necessary to carry pipe-lines a half mile or so from shore into the ocean in order to pump oil out to floating loading docks. Such pipe-lines have usually been pulled out from the shore by tugs, the pipe itself first being welded into one long line. One particular job of this sort which we recall, necessitated the building of a small-gage track reaching in a straight line for hundreds of yards back from the shore. The pipe-line was constructed beside this track, rolled onto small carriages and then towed out to sea.

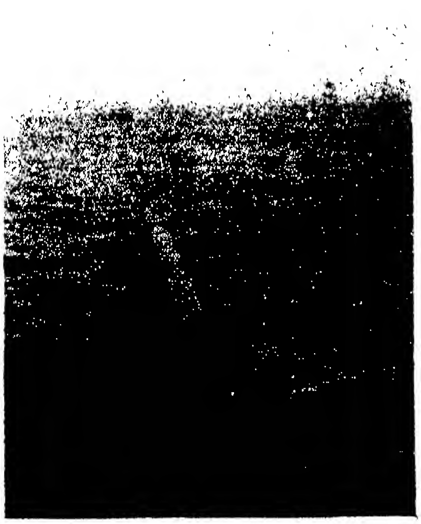
A recent project where it was necessary to extend a sewerage outflow pipe into the ocean was carried out by *pushing* the pipe. The outer or floating end of the pipe was blanked off with a bolted flat head which was later removed by a diver. In the installation, three 60-foot sections were lined up on skids and welded together to make one 180-foot section. This was rolled on to the ways and backed out to sea by donkey engine power. This donkey engine was set up on shore to one side of the inland end of the ways. From the engine, the cables ran to the water's edge, thence through an anchored cable sheave at that point, and back to the rear end of the pipe and parallel to it. When one 180-foot section was pushed out to sea, another one made up of three



Sketch showing general arrangement of method of handling the outfall pipe that was pushed to sea

60-foot sections was rolled onto the ways, lined up with the first, and they were welded tightly together with a sleeve-weld, by the oxy-acetylene process. This process was continued until the full length had been pushed out to sea.

A unique feature of this project was the insertion in the 24-inch sewerage pipe of a four-inch pipe which was kept full of water as ballast. This water stabilized the main pipe in the heavy seas, and was necessary because there was no breakwater or other protection against the surge of the surf. When the line was completed, a cable pulled the four-inch pipe out of the main 24-inch line.



A sewer pipe is pushed to sea

BRITISH TRAIN RECORD

WORD from England tells of a new record of 108 miles an hour with a new steam locomotive of the London Northeastern Railroad. Whether significant or not, the locomotive's name is *Papyrus*, after the well-known horse which won the Derby.

As in America, steam-powered railroads are unwilling to admit that the new lightweight type Diesel-powered trains alone can go places in a hurry.

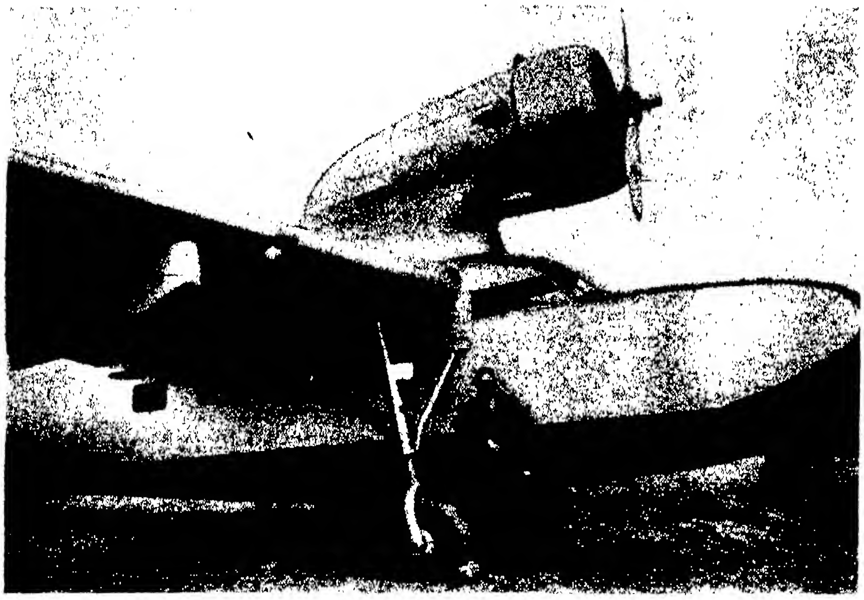
While English circles may regard *Papyrus'* speed as a record, American "old timers" will jog their brains a bit and think back to 1904 when the Philadelphia & Reading put one of its crack trains through its paces and came up with a speed of 115.20 miles an hour; or they recall the run on the Michigan Central in the same by-gone year when 111.90 miles an hour was attained. Even in 1893 the New York Central's Empire State Express sped a measured mile in 32 seconds and thus traveled at the rate of 112.5 miles an hour.

Coming closer to 1935, it is hard to find speed records which eclipse the older marks. The streamlined *Zephyr* of the Chicago, Burlington and Quincy R.R. reached a top speed of 112.5 miles an hour during its long-distance run from Denver to Chicago last year.

And there is the special feat of Franz Krunkenberg's streamlined rail car in Germany which, in 1931, went from Hamburg to Berlin at an average speed of 143 miles an hour.

NEW PROTECTIVE COATING STOPS WASTE

THE usual paint film is composed of organic oils in combination with opaque pigments which give it color. Such a film is subject to breakdown and saponification by the actions of acids and alkalis. The effect of the various acids and caustics has long been known, and much work has been done



Three-quarter front view of the *Baby Clipper*, a single motor amphibian

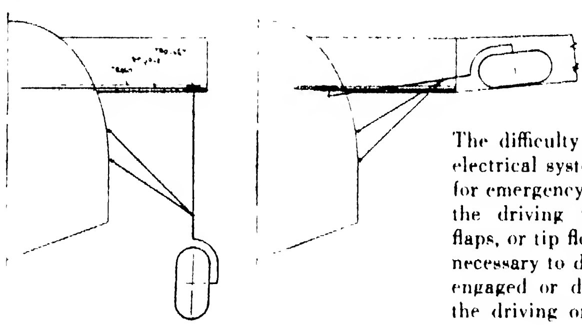
to produce a coating which will withstand these severe reactions. One such coating that holds promise is called Plicote.

In all laboratory tests, Plicote has shown a remarkable resistance to chemicals, and this property has been borne out by actual service tests that have been in progress for more than a year. Tanks coated with Plicote have withstood the action of 50 percent caustic solutions at elevated temperatures. Brine tanks have been coated with unusual success. The activity of fruit and fruit acids in the canning industry has been coped with by Plicote; this product is also tasteless, odorless, and non-toxic.

The New "Baby Clipper"

THE latest Fairchild amphibian, also termed the *Baby Clipper*, is said to be the world's largest and fastest single-engine amphibian transport, and is to be used along river routes in South America operated by Pan American Airways. It is of particular interest because the retraction of landing gear has been carried in this design to the limit of its possibilities, and because the "mechanization" of aircraft controls has also advanced a step further.

The *Baby Clipper*, designed by A. A. Gassner, carries two pilots, eight passengers, and 1000 pounds of mail and express, at a cruising speed of 158 miles per hour with a range of 750 miles. The high speed is 179 miles. The spacious cabin is 16 feet long and six feet high, and has two compartments each accommodating four persons in comfortable lounge chairs. Large windows and the position of the lifting surface afford an exceptional range of view. The mid-wing is mounted approximately half-way between the top and bottom of the hull. The construction is metal throughout. The semi-monocoque hull has six compartments altogether, which are separated by water-tight doors and bulkheads so that the hull will remain afloat even with two adjacent compartments flooded. The single engine is mounted in a highly streamlined nacelle above the wing, and is a Pratt & Whitney



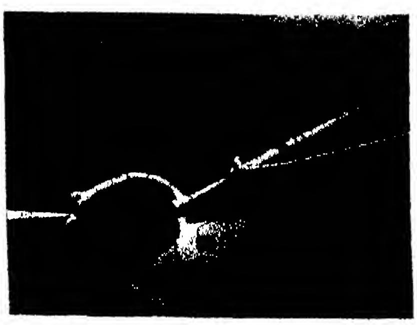
Left: **Diagrams of *Baby Clipper* landing gear in its two extreme positions**

Hornet developing 650 horsepower at 2050 revolutions per minute. The specifications are as follows: Span, 56 feet; length, 46 feet; wing area, 485 square feet; weight empty, 5500 pounds; payload, 2445 pounds; gross weight, 9600 pounds; service ceiling, 18,000 feet; and landing speed, 58 miles per hour.

As stated above, the main special interest of the *Baby Clipper* lies in its retraction features. In this design, the engineers made it possible for the pilot to do the following with smoothness and dispatch:

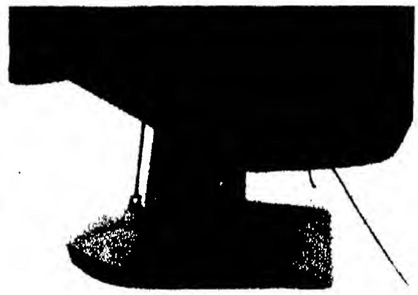
1. Lower flaps to reduce landing speed and landing run.
2. Pull up the main wheels and the tail wheel simultaneously for water work.
3. Retract the tip floats so as to eliminate resistance in flight still more.

Generally speaking, aircraft designers are apt to be secretive as regards the precise mechanism they employ in retracting gears. The Fairchild Company is most generous in its disclosures, which are illustrated by our diagrams. The landing gear structure is so designed that the wheels fold rearward and upward, rotating slightly around the shock strut axis during the retraction. They are flush with the underside of the wing when fully drawn in. The operation is accomplished by turning a spindle (installed inside the front spar flange) which in turn operates a trunnion on the wheel trolley causing the trolley to move inboard or outboard as required. The side brace struts are attached to the main shock strut by a universal joint. The tail wheel, which retracts simultaneously with the landing gear, is drawn into a well on the underside of the hull behind the second step.



One of the landing wheels of the *Baby Clipper* partially retracted

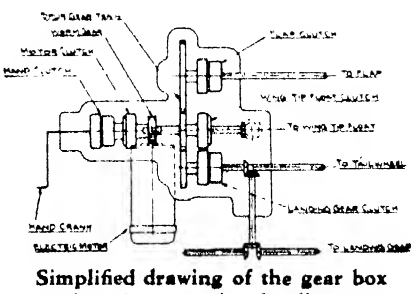
The wing-tip floats retract against the underside of the wing by a parallelogram



Wing-tip floats on the *Baby Clipper* amphibian are retracted by means of a sturdy parallelogram of struts

arrangement of struts, with spindles and trunnions employed here also.

The problem was how to operate these three retraction systems at a distance. Hydraulic operation was ruled out, as being somewhat complicated and unreliable. There was the further difficulty that the three systems had to be operated separately. The difficulty was solved by the use of an electrical system with only one hand crank for emergency use, and a gear box to divert the driving power to the landing gear, flaps, or tip floats as required. It was found necessary to devise clutches which could be engaged or disengaged at any position of the driving or the driven members in the gear box, and a suitable electrical hook-up had to be developed.



Simplified drawing of the gear box used in the retracting landing gear of the *Baby Clipper*, described here

The drive system for the landing gear consists of the spindle with the trunnions already mentioned, to which the retracting trolley was attached. The spindle is turned through a drive-shaft system from the respective gear in the master gear box, and is engaged by operation of a clutch selector lever. When the electric motor is switched on, the drive shaft and spindles turn, and

the trunnion moves the shock strut trolley. When the trolley reaches a point close to the extreme position, it engages a limit switch, the electric current is interrupted, and the spindle and trolley stop.

The designers are to be congratulated on the mechanical and electrical ingenuity they have displayed.—*A. K.*

A Remedy for Airsickness

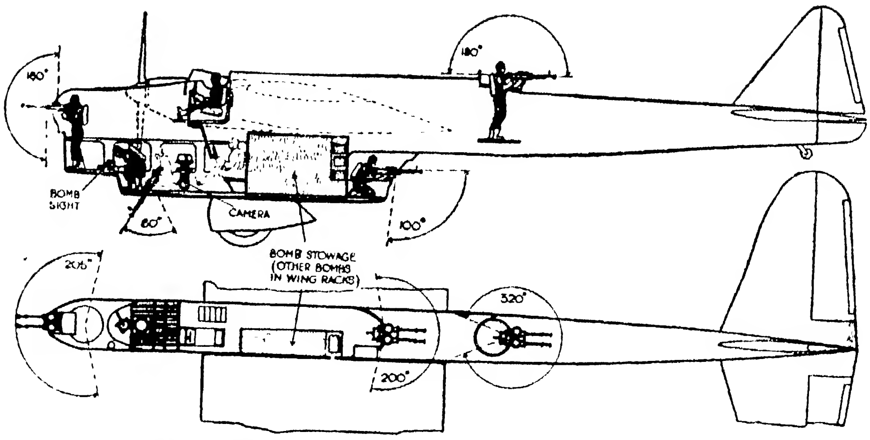
MEDICAL men say that airsickness is often caused by a condition known as "hyperventilation" in which the patient exhales carbon dioxide in excessive quantities. The remedy is to supply the sufferer with carbon dioxide, and the simplest method of insuring this supply is to breathe into a paper bag. Carbon dioxide accumulates in the bag, the patient inhales the gas and his airsickness disappears! Holding the breath for 15 seconds or so is also helpful. This sounds more promising than some of the remedies for airsickness which people sometimes advocate.—*A. K.*

Double-Row Aircraft Engines

DOUBLE-ROW aircraft engines are by no means new. They were used by Anzani, a French company, before the war, and by Armstrong-Siddeley in England soon after the war. In 1928 Curtiss Aeroplane and Motor Corporation employed this principle quite successfully in a six-cylinder radial engine of moderate power. But it is only within the last two years that the two-row radial has become generally available in the United States as an airplane power plant of high power output. Its development has been largely due to Pratt and Whitney, Wright, and the Bureau of Aeronautics in the Navy Department.

Mr. C. H. Chatfield of Pratt and Whitney has recently published an authoritative paper on the subject of two-row engines, and points out their many advantages. One of these advantages lies in greater smoothness and freedom from vibration which follow from an increase in the number of cylinders. Again, as compared with the single-row type, the two-row has more and smaller cylinders. This means a reduction of the stresses introduced in the propeller by explosion impulses. As these stresses are often the critical ones in determining the size of propeller parts, the result is that, for a given engine power and propeller

Side view of the twin Wasp

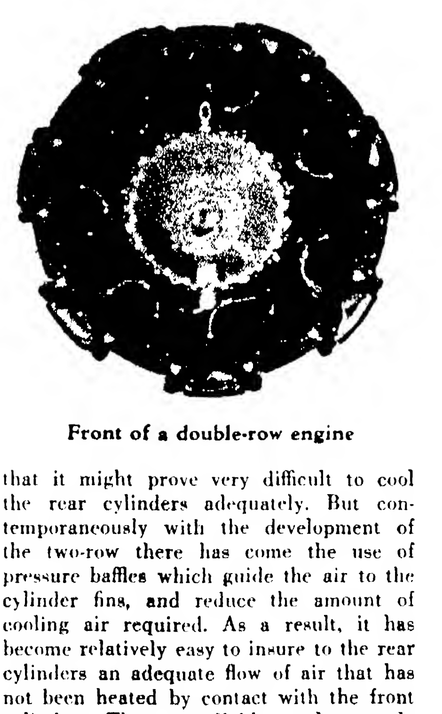


Two drawings that show how armament is placed on the formidable Amiot *143M*

speed, the weight of the air screw for the two-row engine may be safely made less than that for the single-row motor. Still another advantage, due to the smaller cylinders and the greater number of them, is reduction of noise effects. The individual exhaust impulse is less powerful, and the higher frequency of the exhaust noise makes it less objectionable. Longer life and greater reliability are a natural corollary of the above characteristics.

Of course the two-row engines are somewhat more expensive to build and maintain.

When the development of two-row engines was first undertaken, it was feared



Front of a double-row engine

that it might prove very difficult to cool the rear cylinders adequately. But contemporaneously with the development of the two-row there has come the use of pressure baffles which guide the air to the cylinder fins, and reduce the amount of cooling air required. As a result, it has become relatively easy to insure to the rear cylinders an adequate flow of air that has not been heated by contact with the front cylinders. The controllable cowl, recently introduced, is also a help in securing adequate but controlled cooling. Cooling is also more likely to be satisfactory in a two-row because the cylinders are smaller; the volume of the combustion chamber then becomes smaller in relation to the cooling surface of the cylinder.

Although the over-all length of the two-row is greater than that of the single-row, this disadvantage is more than offset by the reduction in over-all engine diameter. In a typical case, there is a reduction in frontal area of 35 percent. Reduction in frontal area means, of course, reduction of air resistance.

Also, with a smaller engine behind it, the propeller suffers less from interference and gives greater propulsive efficiency.

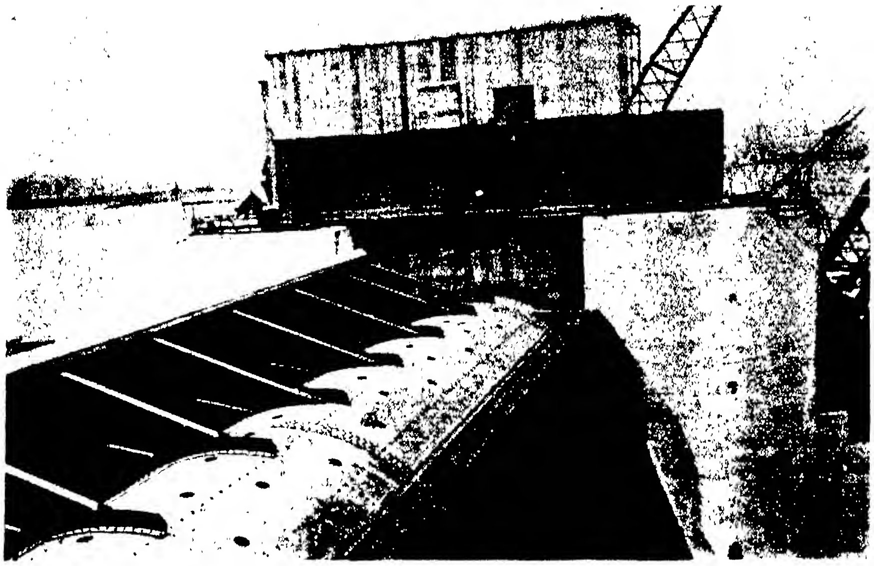
Mr. Chatfield's theoretical analysis is fully borne out by the facts. Thus, the twin Wasp Junior is substantially equal in power to the single-row Hornet, although the piston displacement of the latter is some 10 percent greater.—*A. K.*

Formidable Fighting Aircraft

IN the single-seater fighting airplane, the tradition has been to provide one, or at most two, light machine guns synchronized with and shooting through the propeller. Now the fashion is to carry four guns instead of two. The two machine guns firing through the propeller are still there, but on top of the wings light *cannon* of 20 millimeter caliber are mounted and operated by remote electric control. At the same time, in order to keep up the performance, 14-cylinder double-row engines of 900 horsepower are mounted in some of these single seaters. Certainly these speedy and well armed fighters are formidable weapons of offense.

On the multi-place fighters and bombers, even more powerful guns are mounted, and there are rumors that a French bomber has actually been equipped with one of the famous 75's. This is a far cry from the first early days of the World War, when rival airmen took a crack at one another with revolvers!

While single-seater fighters and two-seater fighters are still found in large numbers in all the air services of the world, there are also many "multi-place decombat" as the French call them. The accompanying diagram gives an excellent idea of the formidable and comprehensive armament of the Amiot *143M*, one of the outstanding French examples of this type of fighting airplane. At the very nose of the ship there is a sheltered gun turret, with two guns. In the open air a man had to be very strong indeed to swing two guns, but when the "sheltered turret" is well worked out, no such difficulty is found. Another gun is mounted also in a sheltered position, on top of the fuselage behind the wing. Below the fuselage there is a hanging car with bomber, camera man and a rear lower gunner at work. Bombs cannot always be placed in the small fuselages, so they are frequently hung below the body just as in the Amiot *143M*. With such an arrange-



Roller gate and concrete pier sill of the electrically heated dam

ment of guns the bomber-fighter can give a very good account of itself in combat, and as will be clearly seen from the sketch it has an almost universal range of fire, front and rear, above and below. Should war really come, it may be expected that aircraft will become even more vicious and formidable.—*A. K.*

An Electrically Heated Dam

In much the same way as water is heated on an electric range, the Mississippi River—or at least a small part of it—will be heated by giant Calrod-type electric heating units now being manufactured by the General Electric Company, the purpose of which will be to facilitate the operation of the gates of a dam near Canton, Missouri, during freezing weather next winter and spring.

The reason for this apparently unusual use of electric heat is that the government is building a new roller-gate type of dam at Canton, representative of the latest American engineering practice. The main gates will consist of huge rollers or drums, some of which will be 109 feet long and 20 feet in diameter, placed horizontally across the stream. The ends of the drums will rest on sills built into the concrete piers and will be so arranged that each drum can be partially rotated and raised to vary the flow of water or allow ice to pass during the spring thaw.

In order to permit year-round operation it will be necessary that the ends of the drums be kept free from ice. The giant heating units will be installed in the drum ends and pier sills to prevent freezing. Some of these heating units are as much as 27 feet in length, but, despite their huge size, the power required for heating one end of a roller will be only 18 kilowatts.

Boric Acid Ice Protects Fish in Shipment

Freezing fish in a film of boric acid solution has proved a boon to Canadian shippers of finny foodstuff. When frozen fish are shipped in an unprotected state, they lose moisture rapidly and the flavor of the fish is impaired. For some time it has been the practice to seal the fish up in a film of ice, in order to keep the natural moisture in the flesh. This layer of "glaze" is easily broken in handling, so the method has not been entirely satisfactory. Now chemists at the Canadian Fisheries Experimental Station at Prince Rupert, B. C., have discovered that a tough "glaze" can be formed over the fish by freezing a solution of boric acid on them. This boric acid ice does not crack easily, and a chip may be broken out of it without injuring the surrounding surface. Very little of the acid penetrates into the fish. The acid also serves to keep down the bacteria which cause reddening of the fish. The method is proving very satisfactory.—*A. E. B.*

LATEX

The amount of liquid latex used in 1934, according to the Goodrich Rubber Company, would equal in volume a five-minute flow of water over Niagara Falls.

Fever Treatment In Arthritis

A patient suffering from one type of arthritis, that due to the gonococcus "germ," has an 80 percent chance of being promptly cured by a few sessions of fever treatment, according to Dr. Philip S. Hench of the Mayo Clinic. Dr. Hench showed pictures of some patients afflicted with gonorrheal arthritis or rheumatism hobbling around painfully on crutches one day and walking briskly about 24 to 48 hours later. Early and efficient treatment is necessary to obtain the best results.

"Unfortunately germs supposed by many to cause the common forms of rheumatism (chronic deforming arthritis) are usually resistant to heat and apparently are not killed by the amount of fever which it is safe to induce in human beings," Dr. Hench said. "While fever therapy in the hands of specially trained physicians and assistants is essentially a safe procedure," he continued, "the reactions must be carefully controlled at all times by attendants. Such treatments cannot therefore yet be said to be cheap, and the day when anyone can turn on his own electric apparatus and cook away his disease in the fires of fever has certainly not arrived, probably never will."

Dr. Hench described the effect of the fever treatment as follows: "A whirlpool of physical and chemical reactions occurs during the induction of such a 'friendly-fever' in human beings. Blood vessels change their size; the blood, kidney excretion, and sweat are altered in their content, and it would seem that the immunity mechanism of the patient is enhanced. The most important discovery is that the germs of gonorrhea and syphilis can actually be killed if enough fever can be generated in the patient."—*Science Service.*

Britain to Build New Non-Magnetic Ship

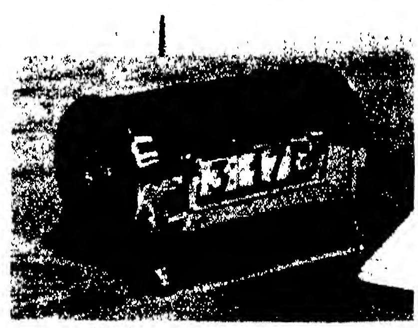
Built almost wholly without iron or steel, a new non-magnetic ship is planned by Britain to replace the lost *Carnegie*, formerly operated as a cruising laboratory by the Carnegie Institution of Washington. The *Carnegie* was destroyed by explosion and fire while refueling in the harbor of Apia, Samoa, November 29, 1929.

A non-magnetic ship has tremendous practical importance as well as great scientific value. The deviation of the compass from true north varies from place to place on the earth, and changes with time. Hence if navigation charts are to be made and kept accurate, exact compass determinations have to be made periodically.

Paradoxically, although compass accuracy is more important at sea than on land, it is easier to achieve on land than at sea. This is because ordinary ships, even wooden ones, contain so much iron that they disturb the delicate instruments and falsify their readings.

Because of this, the Carnegie Institution of Washington built the non-magnetic yacht *Carnegie*, replacing practically all iron and steel fittings and machinery with bronze and other non-ferrous metals. Even the two internal-combustion engines she carried were almost wholly bronze, the only iron in them being the linings of the cylinders. So small a matter as the iron in the "tin" cans of her stores was a cause of concern to the scientific command.

After the loss of their ship, the Carnegie Institution of Washington decided not to replace her. The British Admiralty, in view



Courtesy The Pennwood Company

One of the latest self-starting electric clocks on the American market offers an added attraction of "automatic" time telling. Four dials show the time to the second. All moving parts are enclosed with a permanent supply of lubrication; the motor is supported in alignment by a one-piece metal chassis

of the Empire's great maritime interests, has, therefore, undertaken the construction of a non-magnetic ship of their own. Parliament has just authorized the expenditure of 10,023 pounds sterling as first installment of her cost. Details of the plans are not yet public, but it is probable that the new ship will be larger than the *Carnegie.—Science Service.*

ASBESTOS

THE ancients recognized the non-inflammability of asbestos, for, according to Westinghouse, the lamp wick of the sacred fire of the goddess Vesta, attended by the Vestal Virgins in Roman times, was made of this rock fiber.

Remaking Geography

SCHOOL children of the immediate post-war years were bewildered and seriously hampered in their studies not only of geography but of the history of Europe because of the many changed boundary lines and new countries. If the present fad for changing well known place names and country names holds, the student will be more than ever bewildered because, as new maps are drawn, the map makers do not take into consideration the fact that students ought to have, in addition to new names, the older, more familiar ones.

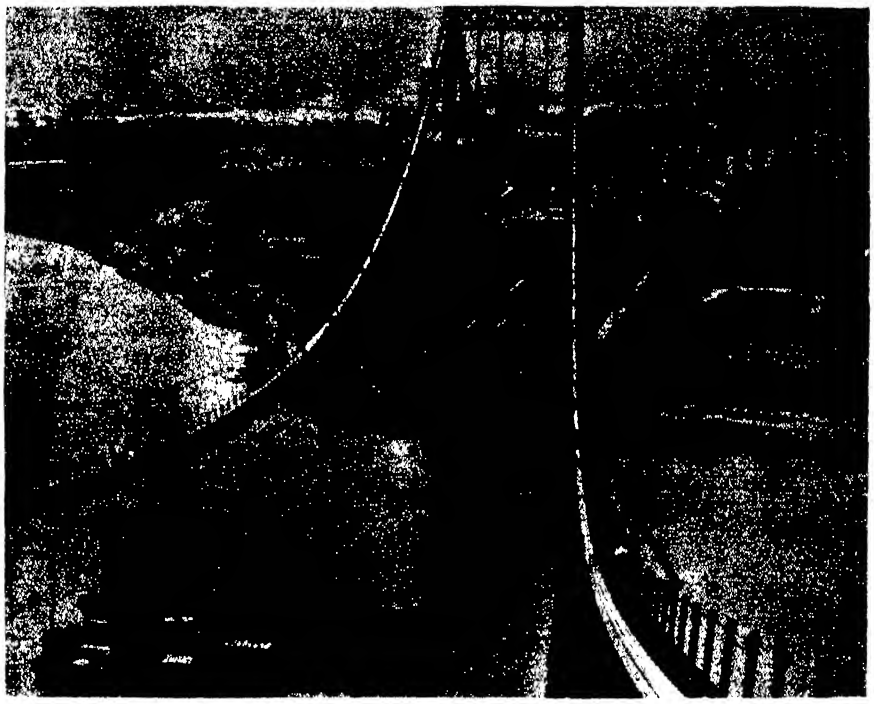
Passing quickly over Russia which, because of a changed social system, feels called upon to change old names without rhyme or reason, we find more stable countries taking new names or re-adopting old ones and insisting that they be used throughout the world. It has been difficult enough for everyone to become familiar with Chosen as the Japanese name for Korea; now Persia insists upon world use of its ancient name Iran, and Abyssinia wishes to be called Ethiopia. Some other requested usages are listed below with the older, more familiar designation following:

Oslo—Christiania
Istanbul—Constantinople
Peiping—Peking
Marseille—Marseilles
Warszawa—Warsaw
s'Gravenhage—The Hague
Firenze—Florence
Praha—Prague

Electric Boats

HEAVY-DUTY storage batteries provide the motive power for a new line of boats developed by Electri-Craft Corporation. It is stated that one charge of the storage batteries for one of their models makes possible 40 hours of cruising, permitting travel totalling 195 miles. The cost of operation is, therefore, said to be from two to five cents per hour depending upon the size of the boat and the rate per kilowatt hour. The major advantages are quietness, lack of vibration, and extreme simplicity of operation. Batteries are charged while the boat is docked.

Because of the quiet operation of these boats and the freedom from oil and grease, they are permitted in waters generally prohibited to power boats.



Science Service

The Triborough Bridge, linking the boroughs of Manhattan, Queens, and Bronx, New York City, takes shape. This view shows the workers' cat-walks over the famous Hell Gate. One of the ingenious features of this bridge is the ramp system at the western end, where the traffic will be divided without undue congestion

"One-Way Paint"

THE development of paints with a "valve-like" action which would allow one-way passage of moisture, is predicted for the near future by Dr. H. A. Gardner, Director of the Institute of Paint and Varnish Research.

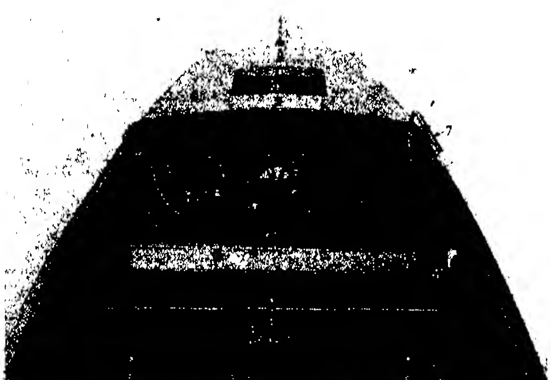
Speaking before a regional meeting of the American Society for Testing Materials, Dr. Gardner foresaw the use of a paint which would permit moisture to escape from the inside surface but prevent its entrance from the outside. The attempt of moisture in the wood to get out through a paint film is a frequent cause of paint blisters. This tendency is apt to become more of a problem as our homes and factories are provided with dry air by the general use of air conditioning.

Dr. Gardner said that this new type of paint might be made by the use of "pigment aggregates having specially shaped particles."—*A. E. B.*

Sound Meter Aids Deaf

A DEVICE expected to be of considerable aid in instructing the deaf to speak with normal intonation of the voice has been designed at the Cruft Laboratory at Harvard University by Frederick V. Hunt, instructor in physics and communication engineering. The apparatus is essentially a refinement of instruments already in use for measuring sound frequency or pitch.

Minute voice fluctuations are translated by the apparatus into electrical impulses, as in the telephone, and are instantaneously registered on a small dial. A deaf person using the device watches his voice fluctuations on the dial, modulating his voice until he obtains a reading similar to that of a normal person speaking in ordinary tones. *Science Service.*



Left: **Power unit in standard model of the electric boats described in these columns. 1 is the motor; 2 the storage batteries; 3 the speed control switch; 4 the directional control switch; 5 charging switch; 6 combination light and charger switch; 7 steering control**

America's First Submarine Cable

WE have just run into a most interesting situation. A Canadian subscriber wrote us recently that a tablet had been placed on a building at Charlottetown, Prince Edward Island, with the following inscription: "First Submarine Telegraph in America. Commemorating the laying of the first submarine telegraph cable in America. It extended from Carleton Head, Prince Edward Island to Cape Tormentine, New Brunswick.

Laid by Frederick Newton Gosborne, Monday, November 22, 1852." Our subscriber was inclined to doubt priority of this installation and asked that we check our early files to see whether we could find record of a previous installation. We found it.

In our September 18, 1858, issue a letter discussed the laying of a submarine cable in July, 1848, at the bottom of the Hudson River between New York and Jersey City. It read in part: ". . . In the autumn of 1846-7, two lines of wire were thus insulated with a compound of india rubber and sulfur for Mr. Hugh Downing, the President of the House Telegraph Company, for connecting this city and Philadelphia by telegraph; and in the months of April, May, and June, 1848, a large amount of small iron and copper were insulated and covered with gutta percha by Mr. Reynolds, for persons connected with the Morse lines; and in July of that year four miles of No. 9 iron wire were insulated with a double coating of gutta percha by the same gentleman, a part of which cable was placed at the bottom of the river between New York and Jersey City. . . ."

Clean Air Electrically

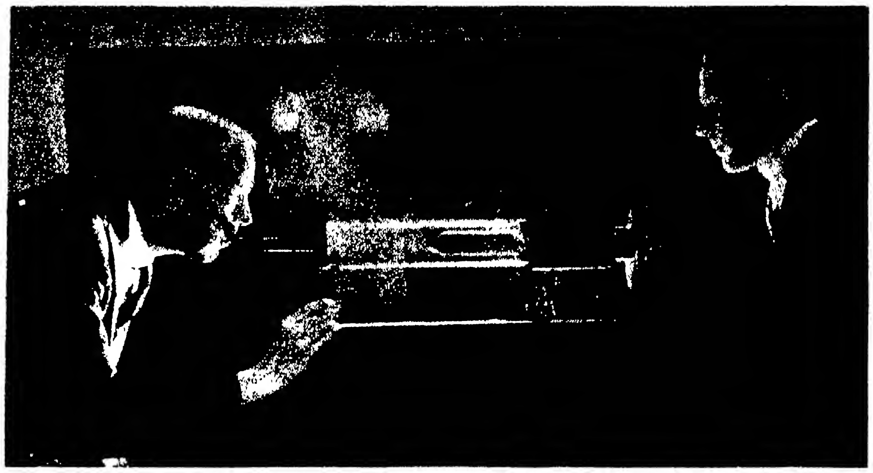
DEVELOPMENT of an electrical unit to remove dust, soot, pollen or other solid and liquid particles in air has progressed to the point where engineers of the Westinghouse Electric & Manufacturing Company now have several experimental models installed in homes and offices of the Pittsburgh district.

Data is also being gathered by physicians who are using the units in their treatment of patients afflicted with any of the numerous types of asthma or pollen fevers.

Electrically, the unit is a comparatively simple device. It is so arranged that it draws particle-filled air past two small wires, suspended horizontally. Connected to a power pack, which raises their voltage, these wires "charge" all air particles in their vicinity. This act is termed ionizing the air. Next the ionized particles are drawn through a series of plates which are also charged. The plates have opposite polarity, with the result that just as a needle jumps over to a magnet, so do these air particles move and cling to the plate. Thus the air is made to clean itself. In addition, a film of oil covers each plate to make certain that the particles, after being attracted, stick to the plates. The air, freed of particles, is then sent on into the room by means of a fan. The unit requires only about 50 watts to operate. After the plates fill up, they may be cleaned in running water.

In certain sections of Pittsburgh, 97 percent of the impurities collected was in the form of soot. In outlying sections, the larger percentage of particles consisted of various irritating pollens.

Hay fever victims who have used the cleaner have stated that relief came to them within fifteen minutes after they had been in a room where the air had been electrostatically cleaned.



An experimental model of the device for cleaning air electrically

Huge insect traps, using mercury-vapor glow lamps as "bait," have been found effective in capturing the Asiatic garden beetle. In the West, specially colored lamps serve as "bait" for trapping fruit flies

Chemistry Speeds Linen Manufacture

AMERICA may take a position of leadership in the production of linen textiles if the hopes of Howard D. Salins of Chicago prove well founded. This chemist has worked out a process for treating the flax which, if successful, will greatly facilitate and cheapen linen manufacture. The inventor claims that his process, details of which have not been made public, makes possible the removal in two hours of the gummy substance that holds the fibers of flax together, whereas it takes two months under the dew-retting process in general use in Europe and Canada.—*A. E. B.*

Bones Not Rigid And Unchanging

BONE is not the hard, stiff, unyielding, almost stony stuff we get used to thinking it is from examining it when dead and dry. So long as it is a part of the living body it is plastic and accommodating, readily making way for changes that take place in living organs of softer tissue located in or on it. So Dr. Charles B. Davenport of the Carnegie Institution of Washington recently told the American Association of Physical Anthropologists.

Dr. Davenport based his assertion on X-ray studies of a certain cavity in the base of the skull, photographed at one-year intervals in a considerable number of individuals. He found that this cavity increases in size with age. Other bone studies gave additional support to his thesis of the relative plasticity of living bone.—*Science Service.*

Baltic Sea Highway

AN automobile highway, encircling the Baltic Sea, and running through eight countries, is planned by the Joint Scandinavian Tourist Committee which reports that the new route will be ready as soon as the Norwegian State Highway is completed.

In the future, therefore, international tourists will be able to start from Hamburg to Copenhagen, Helsingör, Helsinborg, and proceed through the Swedish chateau country and the beautiful lake regions of central Sweden to Stockholm. From Stockholm the road will go to Oslo, or farther north through Sweden, and then along the Norwegian State Highway to Petsamo, on the northern coast of Finland, at the Polar Sea. From Petsamo the route will continue southward through Finland to Helsingfors, Leningrad, Tallinn in Estonia, and Riga in Latvia, and thence via the Polish Corridor to Berlin. The route will offer an extensive variety of scenery, ranging from fertile plains and virgin forests to majestic mountain scenes, and enable tourists to visit eight capitals.

Plastic Stove and Furnace Lining

DOMESTIC stoves, ranges, furnaces, and boilers now may have their efficiency raised through the use of a new plastic refractory material which is distributed under the name of Fireline. The manufacturer claims this new lining will give industrial combustion efficiency to home heating plants and burners, that it will raise the combustion temperature, reduce soot, smoke, and ashes, and increase the heat capacity of any domestic plant burning solid fuel.

Fireline comes in plastic form and, it is reported, can be properly installed by anyone with a mechanical bent. It is said to

make firepots gas-tight, to resist shock and erosion, to be non-cracking, and to have sufficient strength to repair cracked, broken, or burned-out firepots permanently. It comes in 2½, 5, 10, 50, and 100 pound cans and is applied from one to two inches thick over firepot wall from grates to fuel line. It is guaranteed to withstand temperatures to 3000 degrees, Fahrenheit, without cracking, fusing, or spalling.

"Enduro," an 18-and-8 stainless steel, now makes its contribution to music. Guitars, said to have excellent tonal qualities, are being made of this alloy, which contains 18 percent of chromium and 8 percent of nickel

Courtesy Nickel Steel Topics

BOOTLEGGERS

COAL bootlegging is now estimated to total 40,000,000 to 50,000,000 dollars a year and employ 100,000 people. Miners no longer able to salvage coal from dumps, because of better sorting machinery, started mining their own in small exposed seams and gradually expanded this work until it is quite a business, the work mostly being done at night.

A Photographic Studio in Miniature

THERE is a fascination in making photographs full natural size or larger which ordinary photography does not possess. The one reason that it is not practiced more commonly is the difficulty encountered in maintaining the proper relationship between camera and object. When working with sizes larger than natural, the slightest movement will destroy the focus and will probably displace the position of the image.

The use of an optical bench will overcome the difficulties mentioned, but it is usually somewhat difficult to alter the usual optical bench accessories to make them suitable for this purpose.

An optical bench has now been introduced which is designed for photographic work of the kind described, and is intended for amateur as well as more serious use. The bed of the bench is like that of a well-known optical bench, but saddles and accessories have been made especially for photography. A camera head permits the camera to tilt in a vertical arc, to swing horizontally through a complete circle, and to be raised or lowered.

Two vee troughs serve to support lens extension tubes of 20 inches in length or even more. The most elaborate accessory is the stage itself. This measures five by eight inches. It has five-inch uprights at the back which are grooved to take backgrounds of transparent, translucent, or opaque material of any color.

The stage moves in a direction parallel to the bed by micrometer screw control. This is operated from the camera position by means of a flexible cable adjustment. This permits the finest adjustment of focus to be made *by changing the distance between the lens and the object*, from the operating position behind the camera. The entire stage with its controls may be raised or lowered in coarse adjustment by a friction post and in fine adjustment by a micrometer screw adjustment.

Lighting of any kind may be obtained by using one or both of the lamps which are attached to the stage by means of swinging arms. Shades are provided to keep glare from the lens.

The entire bench is designed to make possible assured results in the fascinating field of photomacrography, that field which lies midway between ordinary photography and photomicrography.

Rayon in Better Tires

ARTIFICIAL silk as strong as structural steel is the latest remarkable product of synthetic chemistry, according to Lammot duPont. This high-strength rayon was developed especially for use in the manufacture of cord tires and it has been appropriately named Cordura.

Although considerable progress has been made in the construction of cord fabric for automobile tires, most of the recent improvements in tires have been directed along the lines of improved rubber accelerators, anti-oxidants, and the conditions of vulcanizing. The development of Cordura is expected to prolong still further the life of tires. Indeed, it promises to double and triple the mileage of heavy duty truck and bus tires.

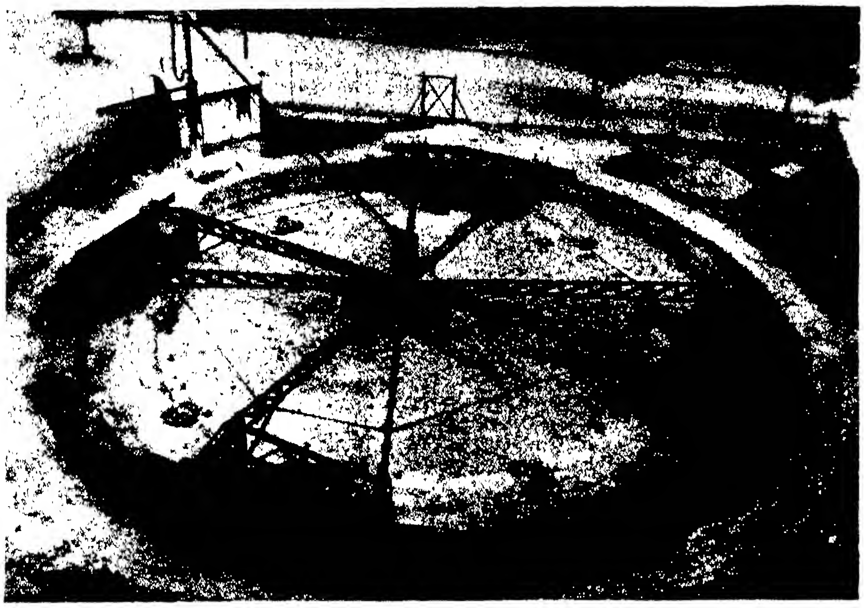
The rayon manufactured for this purpose is produced under special conditions of manufacture. It is said to be as strong as structural steel of the same cross-section. It also has low elongation and a very harsh and unpleasant feel as compared with the rayon manufactured for fabrics. It possesses, however, unparalleled resistance to heat degradation.—*A. E. B.*

Fused Collared Shirts

WHEN the first splashy advertising of the new wiltless collared shirts appeared in newspapers recently, there was some bewilderment as to how this development had come about. When it is explained that these collars are fused by the Trubenizing process, the question begins to clear up. As a matter of fact, the outside cloth is fused, or perhaps it might be better to say glued, to the lining cloth. Dr. Benjamin Liebowitz, an engineer, is credited with the development.

The Trubenizing invention employs an arrangement of threads of cellulose ester as both a stiffening medium and a binder for uniting the lining with the outer and inner plies of collars, cuffs, or other textiles. The different layers of cloth are laid with the lining threads of cellulose between them and spaced about every fifth thread. This spacing is necessary to prevent filming over or closing when the finished cloth

A photo-optical bench that permits the amateur photographer to conduct serious experimental work in the field of photomacrography is now available. At the left above the bench is shown in use with a camera firmly fixed to a head which is adjustable in all directions. At the right the operator is controlling adjustment of the stage by means of a flexible cable, at the same time focusing for an enlarged image. The extension lens tube is held in a vee trough



Courtesy California Highways and Public Works

Road materials are tested under conditions closely approximating actual traffic use in this test track set up by a German highway laboratory. The track is about 70 feet in diameter and permits the testing of a strip of road material from 6 to 10 feet wide. The loaded wheels that constantly grind away on the surface can be shifted sidewise to cover the entire width of the experimental roadway

is treated with a solvent. A preferred method of solving the artificial threads is to place the collars between two pads, wet with acetone, and then to apply pressure. Heat and further pressure are applied, as a result of which the solvent is driven off. The cellulose ester remains behind no longer as a fabric, but as a checkered structure partly dispersed into the adjoining fabric plies, which checkered structure adhesively binds the plies together and stiffens them.

SHIP POWER

ONLY two vessels on the sea today have greater rated horsepower than the new French Liner *Normandie*. Her electrical power plant is rated at 160,000 horsepower while both the aircraft carriers *Lexington* and *Saratoga* have 180,000 horsepower.

Poison Ivy, Poison Sumac

VACATIONISTS as a rule dread nothing more than "getting a dose of poison ivy." The unsightly blisters, the unendurable itching, the frequently prostrating allergy or "shock effect," can combine to ruin a holiday as hardly any other woodland plague is able to do.

The best prevention is to keep away from it. To do so, you must know it when you see it. That is not difficult. Poison ivy is either a slender low shrub or a vine that clings tightly to trees and stone walls with thousands of little roots. Its distinguishing mark is the triple leaf: "Leaflets three, let it be!" states the old rule-of-thumb. Its flowers are a loose cluster of inconspicuous greenish bloom; its fruits (frequently persistent from the previous winter) are pallid waxy berries. Don't touch it, and you won't get "bit." The notion that ivy can poison at a distance is simply superstition.

If you find you have touched it, wash your hands at once, and very thoroughly. Strong laundry soap is best; the alkali helps to kill the poison. A more thorough remedy, for cases that actually develop, is a 5 percent solution of potassium permanganate. This stains the skin brown, but the stain can be removed later with a weak solution of oxalic acid, or just by thorough washing.

To prevent ivy poisoning, wet exposed parts of the skin with a 5 percent solution of ferric chloride in a half-and-half mixture of water and alcohol. Don't wipe off the solution; let it dry on the skin. This will neutralize the poison.

Some persons are apparently quite immune to poison ivy, and can handle it with no more harm than if it were lettuce. But such immunity is not a certain thing. It can be lost without warning, and once lost seemingly never returns.

Poison ivy is found in all moderately moist open woodlands in the East, and its Pacific Coast twin, poison oak, grows in similar habitats. Even more virulent than these two, though affecting fewer people, is poison sumac, a close botanical relative. This grows only in acid-water bogs or on their margins, so the average person who likes to keep his feet dry is not likely to get into it.

Poison sumac looks like ordinary sumac, except that its bark is a rather pale gray, and its fruits are in loose, drooping bunches of white berries instead of erect, stiff clusters of red-brown fuzzy "seeds." The remedies for poison ivy are good also against poison sumac.—*Science Service.*

Rustproofing With Alternating Current

AN entirely new method of depositing zinc for rustproofing which, for the first time in the history of electro-chemistry, utilizes alternating current in the process, has been perfected by the Ford Motor Company and is now being used in its entire production of head and tail lamps at the Ford lamp plant at Flat Rock, Michigan.

The new process requires less room than other methods of rustproofing, and provides a surface which is ready for painting as it comes from the rustproofing machine. The only attention required before painting is to wipe off the surfaces to be painted with a clean cloth.

The efficiency of the rustproofing may be gaged from the fact that a minimum resistance to rust of 300 hours under salt spray is required by the Ford Motor Company for these parts. In actual laboratory tests complete resistance to rust after 1000 hours of salt spray is being obtained. This is equivalent to years of ordinary use.

The rustproofing machines are entirely automatic. The burnished lamp shell, which has been coated with an oily film, is hung on a conveyor which carries it into the bath, where it stays for 4½ minutes. The bath is kept at 155 degrees, Fahrenheit, and an alternating current of 20 volts, pulling from 35 to 50 amperes at 60 cycles, alternately makes the article to be rustproofed an anode and a cathode.

The effect of this current, it is believed, is not to make the process one of electroplating, but the electricity prevents the formation of hydrogen on the article being treated, and eliminates polarization. The result is that the steel is able to take a coating of zinc by chemical action without interference.

After 4½ minutes in the bath the conveyor takes the rustproofed articles to a hot water spray rinse and dip rinse, and then carries them to the paint booth, where they are dip painted at once after being wiped off with a clean cloth.

If the alternating current were not used, it is stated the deposition of zinc would be very thin and too crystalline, and a great deal of iron would be removed by chemical action and go into the solution.

A feature of the process is that the proportion of metallic zinc in the bath can vary widely and still permit of satisfactory results. It is allowed to vary from 0.9 percent to 0.2 percent.

Measuring Expansion of Metals

A DILATOMETER is an instrument which measures and records, in ten-thousandths of an inch, the expansion and

The dilatometer for measuring accurately the expansion of metals

Portable photo-cell color matchers

contraction of metals as they are heated and cooled. Such a device has been built from specifications of the United States Bureau of Standards for use by the General Electric Company in its investigations regarding metals, and is not a device that the company is marketing.

The dilatometer consists of a small cylindrical furnace surrounding a quartz tube—the quartz withstanding high temperatures and having a minimum of expansion when heated. A round core, about the size of a thick pencil, and made of the metal to be tested, is placed within the tube, which is then electrically heated up to 1800 degrees, Fahrenheit. On top of the specimen is placed another smaller quartz tube, sealed at both ends, to transmit the dilation of the specimen to a dial gage. The gage is connected by an Invar clamp to the outside quartz tube, and can be read to 0.0001 of an inch.

Metals do not expand in an even, gradual way as the temperature is increased, investigations have shown. Instead, they react in an irregular fashion, expanding in spurts. Such irregularities can be determined accurately with the dilatometer. In welding, brazing, or heat treating, information on the reaction of metals to heating and cooling is very valuable. In welding, for example, where one metal is being joined to a different one, the two should cool at approximately the same rate or be heated in a manner to compensate for difference in cooling rate. If one of the metals should cool faster than the other, it would shrink away from the weld and either crack or weaken the joint.

By testing various alloys of different compositions with the dilatometer, it is possible to tell how individual elements are affected by heat variations. After this has been determined it is possible to raise, lower, or even eliminate the critical points of a steel compound, for instance, by adding certain elements. In this way, a compound can be created with nearly any characteristics of expansion and contraction that may be required.—*A. E. B.*

Portable Colorimeter

A PORTABLE colorimeter which can be operated from any 110 to 115 volt light socket has been developed by the M-R-H Laboratories. This new color matching instrument, about the size of an ordinary electrical meter, furnishes its own illumination and gives identical comparison either by day or by night without any effect from outside light sources. It consumes but 50 watts of energy and can be furnished as a six volt battery unit when necessary.

This unit operates much the same as does the one mentioned in our June issue. Light reflected from the samples that are to be color-matched falls upon sensitive photo-electric cells and the vernier scale permits highly accurate matching. The manufacturer claims that it covers such a wide band of color that it goes both into the infra-red and ultra-violet fields of the spectrum.

This new color matcher requires a sample only two inches square in order to make a complete test and sells for a moderate sum.

IMAGES WERE KISSED

IMAGES of the Holy Virgin were much kissed by devout Christians in the 17th and 18th centuries. This caused so much wear of the images that they were finally glazed with mica as a protection.

World's Longest-Span Concrete-Arch Bridge

THE double-track railroad line between Zamora, Orense, and La Coruña, in Spain, will be carried across the Esla River on a concrete-arch bridge, 1545 feet long, which has been in course of construction since August, 1934. This bridge, described by A. O. de Retana in *Cemento* of February, 1935, is to have a central arch of 627 feet clear span, which makes it the longest reinforced-concrete arch in the world. The main arches of the Traneberg bridge in Sweden and of the Plougastel bridge in France, which have held the length record so far, have clear spans of 586 feet and 566 feet, respectively.

The curve of the arch is a parabola of the fourth degree with a rise of 205 feet. As seen from the architectural drawing, the arch carries ten sets of spandrel columns, up to 127 feet in height, supporting the two-track roadway. The arch is a hollow structure divided into three longitudinal compartments, throughout its length, varying in height from 12.1 feet, at the crown, to 19.7 feet at the springing line. The total width of the arch box varies similarly from 25.9 at the crown to 29.7 feet near the abutment. The longitudinal partitions have a uniform thickness of 2.3 feet, while the back and the soffit slabs vary in thickness from 2.95 feet at the crown to 4.35 feet at the abutments.

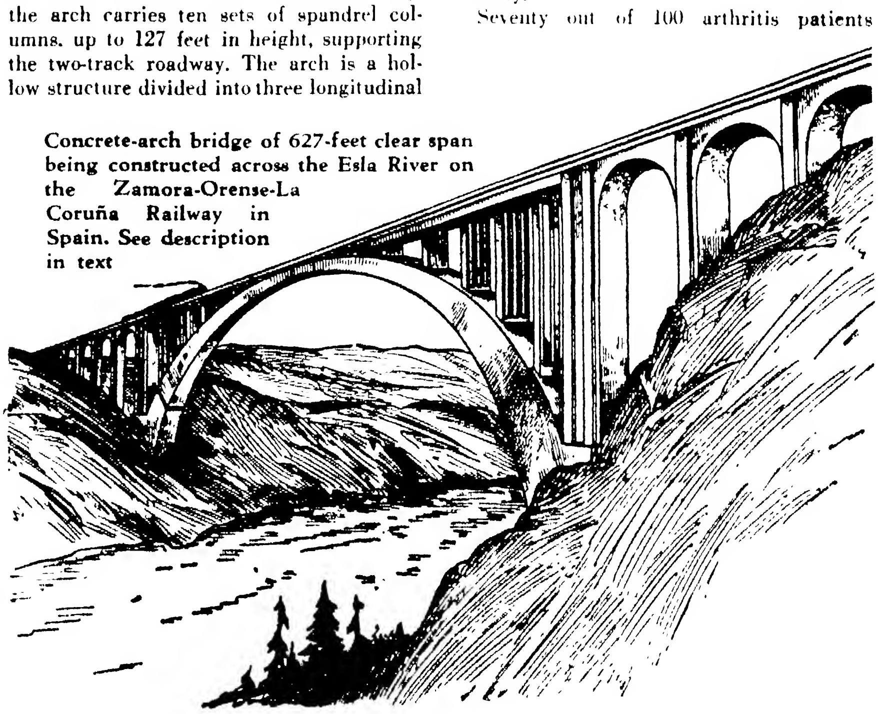
The arch is designed to satisfy the following conditions: (1) skewbacks submerged, or above water; (2) temperature variation of ± 18 degrees, Fahrenheit; (3) wind pressure up to about 28 pounds per square foot. The maximum stresses will be 1182 pounds per square inch at the crown and 1223 pounds per square inch at the abutments. These stresses are only about 28 percent of the 90-day strength of the concrete, which will be proportioned with 590 pounds of Portland cement per cubic yard. The job will require a total of 39,200 cubic yards of concrete and 1100 tons of steel.

The arch centering will consist principally of ten arched-truss ribs forming a system of uniform cross-section 31.2 feet wide and 11.5 feet high. The removal of the centering and the adjustment of the neutral axis of the arch will be carried out in accordance with the Freyssinet system, which proved highly successful in the construction of the Plougastel bridge. Thirty-six hydraulic jacks will produce a positive bending movement of 20,300,000 foot-pounds at the crown, and 1,530,000 foot-pounds at the abutments. The keystone gap will be 6.3 inches wide at the extrados and 5.4 inches at the intrados.—*Engineering News-Record.*

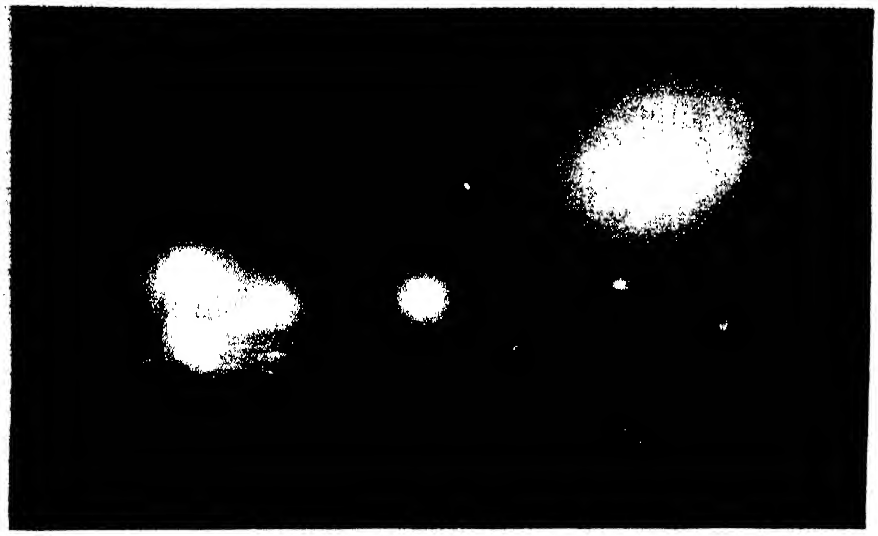
Rheumatism Cured By Vitamin D

RICKETS-PREVENTING vitamin D is of great benefit in the treatment of arthritis, or rheumatism as it is sometimes called, Dr. C. I. Reed of the University of Illinois College of Medicine recently told members of the American Physiological Society.

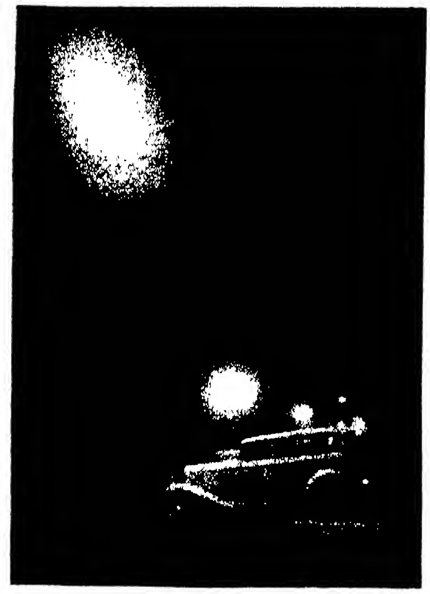
Seventy out of 100 arthritis patients



Concrete-arch bridge of 627-feet clear span being constructed across the Esla River on the Zamora-Orense-La Coruña Railway in Spain. See description in text



Left: **A street in Detroit illuminated with 300-watt tungsten filament lamps that produce 6000 lumens. An experimental set-up of Westinghouse high-intensity mercury vapor lamps, consuming approximately 400 watts produced 14,000 lumens—an increase of 8000 lumens per lamp for an increase in power of only 100 watts. The photograph below shows how sharply the details of objects are defined when illuminated by vapor lamps**



treated this way by Dr. Reed and his associates, Drs. M. L. Hathaway and H. C. Struck, were definitely helped and some apparently cured.

The vitamin was given in the form of concentrated viosterol and enormous doses were used. While 3000 units is the standard dose for rickets treatment, Dr. Reed used 1,000,000 units and in some cases 3,000,000 to treat the arthritis patients. All kinds of arthritis except that due to gonorrhea were helped.—*Copyright, 1935, Science Service.*

BRITISH LENSES

ABOUT 80 per cent of the movies now produced in Great Britain and the United States are photographed with lenses produced at Leicester, England, according to a British publication.

Rubber Protective Coatings

A NEW process which makes possible the use of rubber protective coatings applied in liquid form, has just been developed, according to an announcement by Kelsan Products. For industrial applications, the development opens up new possibilities in many directions. It is reported, for example, that one manufacturer has been experimenting with the possibility of coating a complete automobile body with Kelsanite, leaving it on while the body goes over the final assembly line.

Consideration has been given, furthermore, to leaving the coating on during road test, shipment, or drive-away, removing it only just before delivery of the car to the final purchaser. In this way the body finish would be protected until the car is delivered. Removal of the coating is quite simple, involving merely the loosening of an edge, and then pulling the whole coating off in one sheet, like a Cellophane wrapper.

The cost of providing this protective coating is said to be only nominal and insignificant. Kelsanite is also useful in the masking of automobiles for lacquering.

Another important application of Kelsanite is in the protection of finished parts and equipment for shipment or storage. Parts can be sprayed or brushed with, or dipped in Kelsanite, thereby sealing the surface against air and moisture.

As a rust preventer in storage of metal parts, Kelsanite coated parts have been subjected to over 150 hours of salt-spray tests without showing any signs of corrosion. Kelsanite, it is said, also acts as a cleaning compound, absorbing any dirt or moisture on the surface being coated. When removed it thus leaves the surface clean and dry. In the plating of metal parts Kelsanite has a definite field as a masking compound to prevent deposition of metal except where desired. Following the plating operation, the coating is then readily stripped off.

Rubber protective coatings (Kelsanite) are easily stripped off

High-Speed Army Tank

READERS of these pages have followed in recent years certain of the more important developments in Army tanks and have noted particularly the design of Mr. J. Walter Christie of a powerful tank which would run at high speed on wheels when used on the road and on an articulated track in cross-country runs. The Army has, however, desired a tank of its own design which would also embody most of the good features of others that have gone before. The following paragraphs from *Army Ordnance* give characteristics of such a tank developed by Army engineers:

During the past several years the Army has attempted experimental mechanization. A critical element of the mechanization was the ability to make strategic marches of several hundred miles and then launch an attack. With the full track vehicles having sustained speeds of only 14 or 15 miles per hour, this was not satisfactorily obtained, and the vehicles designed by Mr. Christie filled the gap, permitting strategic marches at speeds of 40 to 50 miles per hour, and then conversion to a track-laying vehicle for use in an attack.

The new tank which has been demonstrated during the past few days to high officials of the Army was designed by Ordnance personnel in the Office of the Chief of Ordnance, Maj. Gen. W. H. Tschappat. This work was greatly facilitated by the enthusiastic support of Maj. Gen. Edward Croft, Chief of Infantry, and personnel of his office. The tank is a full-track vehicle, and is capable of speeds greater than 50 miles per hour and a sustained speed of 30 to 40 miles per hour. The development of this tank is an outstanding automotive development applied to military uses during the past ten years.

After construction at Rock Island Arsenal, this light tank was tested for 2400 miles over irregular terrain and on various types of roads. This test was conducted at the Arsenal. The tank was driven overland by Capt. T. H. Nixon and Mr. Joseph Proske, leaving Rock Island Arsenal on November 14 and arriving in Washington on November 17. During this run all existing records for non-convertible track-laying vehicles were broken. The entire trip of approximately 900 miles was made at an average speed of 30 miles per hour. This included the time necessary in passing through the various cities en route. During one day the tank covered 336 miles in eleven hours.

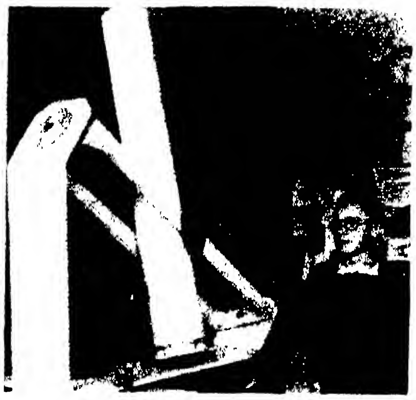
The general characteristics of this light tank are: Length—12¾ feet; height—6½ feet; width—7 feet; weight—fully equipped

(Please turn to page 103)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

EVERYBODY who reads this is hereby automatically invited to attend the tenth annual get-together of amateur telescope makers, to be held Saturday, August 3, at *Stellafane*, near Springfield, Vermont. These annual pow-wows run about as follows: People begin arriving Saturday noon,



mostly by motor. The afternoon is spent in "talking it over" with other hobbyists. At six there is a picnic feed (about one simoleon), at seven an hour's oratory, and the rest of the evening is spent pow-wowing and observing—some go to bed, some sit up late, some return home that evening. Many bring tents to sleep in but there is a hotel in Springfield. Early Sunday morning there is another feed and, as the day wears on, the remaining people drift away. The party offers an interesting 6, 12, or 24 hours of hobnobbing, whichever length you prefer to make it. Bring along your telescope—others will want to see what you've done. About 200 usually attend these corroborees.

WE receive a steady stream of inquiries from amateurs who want to coat their own mirrors by the evaporation process, and our usual reply is: If you have previously dealt with high vacuums, or if you are prepared to do some months of preliminary wrestling with the process, also if you have something under 100 dollars to spend, go to it—you will have a lot of fun or at least "experience." But don't run away with the idea that you can do the job as simply as some seem to believe, or anything like as simply, as the ordinary silvering job. On the other hand, the technique does not seem to be a big obstacle to a man who has had the advantage of a general physical laboratory background. Here is a letter from Gerald E. Kron, 405 La Follet, Adams Hall, Madison, Wisconsin, whose connection

Photos by Oscar S. Marshall

Left: **They start young in California—Richard Cale of Pasadena and his telescope.** ***Right:*** **The Pasadena Amateur Astronomers' Club at John Marshall High School, Pasadena**

with the University of Wisconsin provided him with that advantage.

"Your letter gives me the impression that the amateur telescopists consider evaporating metals quite a difficult piece of work. In a sense this is true, but if one has all of the equipment available, as I did, the evaporation of silver, at least, is quite simple. I built the evaporating outfit and got a coat of silver all in the space of two weeks. But it must be held in mind that I had all of the means of a large university at my disposal, in addition to the advice of several people who had done evaporating before.

"The most important condition for evaporation of metals is to have a high enough vacuum. I believe that any trouble experienced by people who have failed was caused by having too poor a vacuum. It is necessary to have a pressure at least as low as 10^{-5} mm. of mercury, and a very good coat will be obtained if the pressure can be reduced to 10^{-6} mm. [About 1/75,000,000 atmospheric pressure.—*Ed.*] Aluminum is very difficult to evaporate at any pressure higher than the second named above, because it tends to burn up, or acts as a 'getter.' Silver is *by far* the easiest of all the materials that I tried, and I would advise anybody experimenting with the process to start out with it, by all means.

"I produced my vacuum by first pumping down as far as I could with a Cenco [Central Scientific Co., 456 E. Ohio St., Chicago.—*Ed.*] Hi-vac fore pump (about 10^{-3} mm. of mercury). Then the final high vacuum was produced by surrounding a charcoal trap fastened to the apparatus with a dewar flask full of liquid air. The amount of air and other contaminating material that such a trap will absorb (or adsorb) is almost unbelievable. It will reduce the pressure from fore-pump pressure to such a low point that an electrical discharge will not pass through. I used this as a test of my vacuum. It is crude, but quite convenient, and after one learns something about the character of discharges through different pressures,

While telescope making is definitely not a hobby for little children, and has been followed almost wholly by adults, lads of high-school age, particularly after they have studied geometry, can handle the work without difficulty, and it is being used, more and more, by science teachers as "project" work for science classes. Here are two pictures of this kind. ***Left:*** **The Burbank Telescope Club at the Burbank High School, Burbank, Calif., composed of physics students who together made the $12\frac{5}{8}$-inch reflector shown, and individually made other telescopes.** ***Right:*** **Telescope making members of the Astronomy Club at the Snohomish High School, Snohomish, Wash., with 6-, 8-, and 10-inch mirrors. Science teachers are urged to consider using this work next term. Pupils will retain what they learn, long after they have forgotten *mv²*, etc. Wood-working shop, machine shop and laboratory work are involved, and the work is strongly motivated—the romance of astronomy**

he can estimate his pressure with a fair degree of accuracy.

"By far the greatest difficulty encountered was to eliminate all leaks from the system. I believe that the only person in the world who really learns something about leaks is the man working with high vacuum. I know that any of the men working at Wisconsin University will agree with me, and there is a great deal of high vacuum work going on there. The character of the apparatus made it very susceptible to leaks, the apparatus being composed of a large bell jar over a very heavy vacuum plate in which were sealed the necessary electrodes and tubes. Bell jars for such purposes are usually sealed down with a wax of some sort, but I used common Plasticine, a type of modeling clay which never hardens. It makes an excellent seal which is very easy to apply and remove. [J. L. Hammet Co., Cambridge, Mass.—*Ed.*]

"The material to be evaporated is melted with a heavy tungsten filament supported by large electrodes sealed into the vacuum plate. It is difficult to find a material with which to seal these electrodes against the vacuum, and still have them insulated from the metal plate. One of the research men made a glyptol resin for me which is just about the acme of perfection for the above purpose. If anyone you know of would like some of this stuff, I shall be glad to tell him how to make it. It can be melted in place, and yet it is proof against the intense radiation from the filament.

"Many materials can be deposited by evaporation: silver, copper, aluminum, gold, platinum, chromium, quartz, and fluorite. I tried chromium and quartz, but I was not able to get them to a high enough temperature. I have found out, since, that chromium does not give a very bright surface, anyway. Quartz is useful, because it can be deposited over a surface like silver, giving it almost perfect protection. As a whole, aluminum does not seem to stick as well as silver. The latter must be removed from the inside of the bell jar after a run, with an acid or an abrasive powder.

"If anyone you know of would like some help with this evaporating, I shall be glad to answer any questions that I am able to."

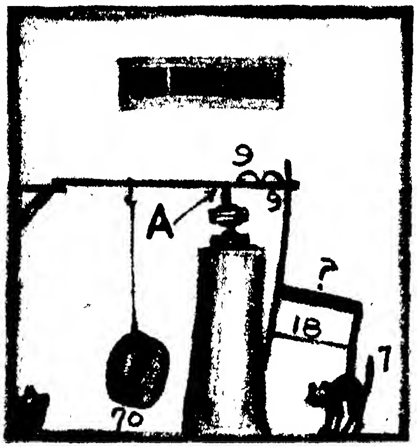
The advantage of aluminum over silver is, of course, that it automatically coats itself with oxide which, being corundum, has the hardness of sapphire. Still, anyone who intends to play with the evaporation game probably would pick up valuable experience from the experiments with plain silver suggested above, later trying aluminum.

A LOT of people are having trouble with pitch for laps. Joseph A. McCarroll, an architect, 521 Palisade Ave., Teaneck, N. J., had so much of it that he got mad and made an investigation of pitch from all angles and, as a result, has decided that the best pitch is not the pine pitch most of us use but coal tar pitch. Only after he had done a lot of experimenting with coal tar pitch did it become known that Ellison now uses that kind. Here is what McCarroll writes:

"Many mirror makers may think that, because there seems to be little or no reference in print to the use of coal tar pitch as a base for polishing, this material is therefore not suitable for that purpose. It will come as a surprise to many to learn

that it is not only suitable, but that in many respects it offers some definite advantages.

"The material to use is *coal tar* pitch. It is a by-product of the manufacture of illuminating gas. The tar is usually sold by the gas companies to concerns that distill it to obtain its many very valuable derivatives so useful in the arts and commerce. Pitch is what is left of the tar after distillation. Coal tar pitch should be distinguished from 'water-gas' tar pitch, which is not nearly so useful to the mirror maker.



With apologies to Rube Goldberg

"Among the advantages of coal tar pitch is a rubbery smoothness of the surface texture of the material when formed in the lap. This probably accounts for the excellent polishing effects obtainable. It seems to work faster and with more positive effect than pine pitch, especially in figuring. It seems that the tendency to cause scratches is less. This may be due to the absolute purity of the material. It is said by the makers that the ordinary run of the pitch, as manufactured, is entirely free from grit or any other foreign substance. It is not necessary to strain it, provided it is packed in clean containers.

"In melting coal tar pitch it is advisable to watch it constantly, especially where the melting point is high. There seems to be a point during the heating when it may suddenly froth up and run over the container and become ignited by the flame. The danger from fire should be carefully guarded against. Water-gas pitch is particularly bad in this respect and should not in any circumstances be used for tempering purposes.

"In making the polishing lap the technique will be found to be quite similar to that used for pine pitch. There will be a marked difference, however, when it comes to cutting facets, as coal tar pitch is much less subject to chipping under the knife. This is a tremendous relief and this one quality alone should commend it highly.

"Such materials as wax, turpentine and rosin cannot be used to advantage for mixing with coal tar pitch for modifying its hardness or other properties, for this kind of pitch is entirely different in chemical composition from pine pitch and, in fact, in making mixtures of either of these materials only such as are of an allied nature should be used. It is true, the two differing varieties of pitch can be mixed, after a fashion, but the smoothness of texture of the coal tar pitch is then lost and gas bubbles will be found to be one of the troubles. Instead, pitch having a higher melting point should be used to harden a similar pitch of low melting point, or vice versa. Creosote oil (common variety) may be used for softening the pitch, although it is better to mix pitch with pitch; if for no other reason, so that one can exactly determine the melting points of the components. For example, equal quantities having melting points at 150° and 200° Fahrenheit will yield a mixture having a melting point of 175°. The range of grades which should be kept on hand for all year round use should run in about 10° intervals from M.P. 140° to 180°. The extremes are useful chiefly for mixing purposes since, if used straight, they would be too soft and too hard, respectively. A melting point of between 155° and 160° will be found to be most generally useful for polishing at room temperatures around 70°. The determination of the melting point of pitch is accomplished by the use of very special testing devices which the amateur would not likely want to bother about. He should get his pitch already graded for melting point.

"The melting point is a very definite property of the pitch, which must be known for basic tempering purposes, but for determining the probable behavior of pitch on the lap under any given room temperature it is necessary to have some other test, such as the penetration test, which will show the specific hardness under existing conditions. This distinction will be apparent when it is realized that a pitch with a melting point of, say, 150°, used in a room at quite low temperature, might have exactly the same specific hardness as a pitch of 170° M.P. in a room of higher temperature.

"Unfortunately the writer, at the present moment, is unable to give very definite suggestions regarding available sources of supply of coal tar pitch in small quantities. It is commonly sold by the ton and in drums containing several hundred pounds. Almost any local roofing concern will have a supply of it, but when using material from such sources straining will be necessary and considerable experimenting with mixing and tempering will undoubtedly be required.

"The writer has been using coal tar pitch for quite a time, under the impression that he was, perhaps, something of a pioneer. Word has recently come, however, that Ellison is using it and favors it for figuring. This should definitely put the stamp of approval on its use."

We intended to reserve this paper for inclusion in the "A.T.M. Supplement," but thought it perhaps better to publish it here first, hoping that other experimenters will report their findings on this kind of pitch before it is set up permanently in that book. In the meantime a source of supply may turn up.

Until we receive a reply from Ellison, all that we can say about his use of coal tar pitch is contained in the following sentence from his last letter. "Coal tar pitch—the very stuff that the paviors use for setting the street blocks—is the best of all for figuring." We have a sample of the pitch he was apparently using in 1928, when we visited his shop, and this appears to be pine pitch; hence he must have taken to using coal tar pitch since that date. Just as we read proof on these pages a rumor that Fecker uses it turns up. Mr. McCarroll at the same time (latest minute) believes he has located a source of supply from which the prepared product may be obtained, but this is as yet too indefinite to state here. Although he is busy, we have urged him to be the dealer himself, because he understands the requirements from the point of view of the amateur telescope maker. Whether he will consent or not, we cannot say, but may have more to say later.

SOME who have written to individuals mentioned in this department, also in the instruction book "Amateur Telescope Making," have evidently ascribed their delayed replies to unwillingness to answer. It is seldom or never that. It will be evident that, when a man's name and address is given here, a flock of letters will converge on him from all directions, and if only one out of a dozen of these includes a stamped return envelope, that one fellow stands to be out quite a bit for postage alone, and his delay may be understandable. Also make it easy for him—tell him to scribble his answer on the margins and back of your letter; why be conventional among fellow hobbyists?

RECENTLY, when writing to Wallie Everest, your old scribe included a sketch of his wonderful, patented, standardized cold pressing equipment, and Wallie returned it with a sketch exhibiting various scientific methods employed in Pittsfield. Both sketches are reproduced on this page. In our own sketch, note tree-

Eurythmic postures in Pittsfield

trunk pedestal; also lever across top, one end bearing on a shelf and shiftable endwise in order to get variation in pressure when single hanging weight is used, and the other end bearing on the handle dingbat shown in A.T.M., page 288, through pivot point *A*, an alley stolen from Scribe, Jr. Two nine-pound hemispheres of lead and an 18-pound chair may be added for heavy pressing, also "Skow," the cat, though she won't often stay put in the chair. (Contrary critters—cats.) Like Topsy and A.T.M., this remarkable outfit "just grew," but we will bet it is no worse than some which the rest of you readers are using, and not so bad as some—and it works. When using heavy weights, rapid unloading may cause deformation of the mirror, hence inventor Everest suggests a washtub which may, if preferred, be filled with champagne, and this weight siphoned off, at the end, into the sink—or elsewhere.

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page 98*)

and with personnel ready to fight—16,000 lbs.; maximum speed—50 miles per hour; sustained speed—30 to 40 miles per hour; engine—260 h. p. radial, air-cooled; track and suspension—special Ordnance design. The tank is equipped with one or two turrets. In every case it carries two caliber .30 machine guns, one caliber .50 machine gun, together with Thompson submachine guns. A crew of four operates the vehicle. A radio with an 80-mile range is provided.

High ranking officials of the Army, and numerous others, were much impressed with the flexibility of control, the easy riding qualities, and simplicity for war-time manufacture of this weapon.

DIAMOND DUST

SOME tropical woods are so dense and hard that a saw with extremely hard teeth is necessary to cut them. The difficulty of sharpening the teeth has been solved by the use of diamond dust.

Cellulose from Sugar Cane Bagasse

EVERY year at our sugar mills there are collected large quantities of bagasse, the fibrous residue which remains after extracting sugar from the sugar cane. In continental United States, chiefly Louisiana, the annual tonnage of bagasse reaches about 500,000, and in Puerto Rico and the Territory of Hawaii there are 2,000,000 additional tons annually. Bagasse is not wholly a waste product. It has some value as a fuel, and it is customary to burn it under the boilers in the sugar mills. As a fuel, one ton of the green bagasse is equivalent to about one barrel of oil. With fuel oil selling at $1.00 to $1.25 a barrel, the fuel value of this material is not high. Some bagasse is used in the manufacture of structural insulation board, but this industry has never absorbed over 20 to 25 percent of the continental supply.

The comparatively high cellulose content of bagasse has suggested its use as a source for paper pulp. Some attempts at producing paper pulp from bagasse were unsuccessful. The value of pulp in paper making depends on its felting quality, which in turn is dependent on the length of the fiber. Some of the bagasse fibers are long, but a large proportion of them are short. There is some demand for short fiber pulp, but it must be mixed with some long fiber pulp to produce acceptable paper.

During the last 15 years, there has been an enormous growth in the demand for cellulose for other uses than paper. In that time we have witnessed the growth of the rayon, staple fiber, and transparent sheet cellulose (Cellophane) industries. Little rayon was produced in the United States in 1920, but in 1934, 208,000,000 pounds were manufactured in this country, and the world production for 1934 was

735,000,000 pounds. The other two developments are of a later date, and no one acquainted in these fields will hazard a guess on the yearly amount of these materials the world will require.

Experimental study in the Bureau of Chemistry and Soils showed that the pulping of bagasse could best be accomplished with dilute nitric acid. The availability of cheap nitric acid, due to the low price of ammonia, indicated commercial possibilities along this line. An experimental pulping method using dilute nitric acid was developed during this research. Interest in the work was evidenced by some concerns having large quantities of bagasse at their disposal, and the Bureau is co-operating with some of these companies in the commercial development of this process, with encouraging results. From this farm by-product, which is a waste to the cane sugar planter, high-grade industrial alpha cellulose has been prepared which compares favorably with any industrial alpha cellulose purchased by the rayon mills, and at a price to compete with standard grade of industrial alpha cellulose. Bagasse is, therefore, a potential source of one half a million tons of industrial alpha cellulose for the continually expanding high-grade cellulose industries.

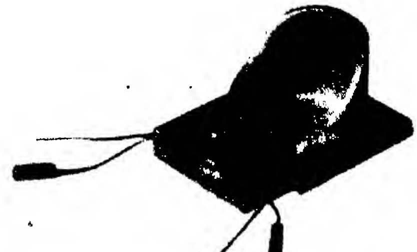
Black Concrete

CARBON black is an important constituent of automobile tires; now it is also being used in the concrete roads over which those tires roll. Introduced into the concrete in order to produce a dark color which cuts down road glare and to afford more contrast between traffic lanes, it has been found to improve the strength of the concrete as much as 25 percent. The colloidal black, besides coloring the concrete, improves the bond between the hydrated cement and aggregate, thereby increasing the strength of the concrete. It seems quite probable that these aqueous dispersions of carbon black will have a considerable use, not only for darkening, but also for increasing the strength of many compositions, such as concrete, mortars, and artificial stone.—*A. E. B.*

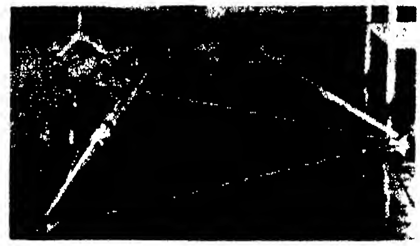
Immovable Tripod Base

ACCOMPANYING photographs show a type of tripod base which should be very useful to surveyors, photographers, or others who use tripods on hard or slippery surfaces. This device consists of three cast aluminum "sockets," on the bottom of each of which there is a rubber pad; the three sockets are tied together, when spread by tripod legs, by a tough adjustable cord.

With this device it is possible to adjust each leg separately or to slide the three legs as one unit into any position without altering their relative positions. This tripod base is light in weight and takes little space when not in use.



One of the metal sockets that are used in the immovable tripod base



Metal sockets linked together form a satisfactory base for any tripod

Peppermint After Heavy Meal

THE popular custom of offering guests peppermint candy or peppermint cordials after a heavy meal has scientific support in the findings of four Chicago physicians, Drs. H. I. Sapoznik, R. A. Arens, Jacob Meyer, and Heinrich Necheles, who reported on their investigation in the *Journal of the American Medical Association*.

Tests made both on dogs and on human beings showed that the oil of peppermint that is present in peppermint candy has a decided motor action on the stomach. Digestion is speeded up, and the stomach empties an hour faster. The peppermint is particularly useful after a meal with a high fat content, making the person's stomach feel less full and distended.—*Science Service.*

Belt Drives for Aircraft

IN the design of flying boats and amphibians, there is always some difficulty in locating the engine. To provide the necessary propeller clearance above the hull, the engine must be placed rather high up. Hence it is usually located above the wing (as, for example, in the Fairchild *Baby Clipper*) where it is not readily accessible and where it creates air resistance.

A more practical arrangement would be to have the engine in the hull and the propeller above the wing. But then there arises the problem of transmitting power through shafting and gearing. That means noise and weight, two of the enemies of the aircraft designer. Accordingly, considerable interest is attached to an experiment being tried by the Casey Jones School of Aeronautics, in which the engine is to be placed inside the hull, and a belt drive will transmit power to the propeller. A few years back such an experiment would have been unthinkable. Now engineers have made so much progress in increasing the life and smoothness of operation of belting, that they are perfectly confident of giving the aircraft industry a new and satisfactory transmission system.—*A. K.*

Sprinkler Head Split-Second Operation

ONE tenth of a second after the heat struck the solder, water deluged the fire in sufficient quantities to extinguish it

—45 gallons per minute. Such was the remarkable automatic action of the Rockwood Type "D" Sprinkler Head recorded for the first time in history of the sprinkler industry by a high-speed movie camera in the laboratories of the Rockwood Sprinkler Company, at Worcester, Massachusetts.

Despite the excellent field service record of this head as a fire extinguishing device, and many laboratory tests made by insurance underwriters and themselves, the company engineers determined to make use of the high-speed movie technique that has only recently been developed, to establish a picture study of an operation that is too quick for the eye to follow.

Taken at the rate of 192 frames per second, these films showed that it required only one tenth of a second for the sprinkler head to operate from the time heat of the proper degree struck the solder until water was deluged upon the fire. Besides showing the extreme speed of the sprinkler head, these films also furnished an excellent study showing the actual movement of parts and the distribution of water. In the various picture frames the flying parts of the head actually appear to float in the air; the acceleration due to gravity, increased by the snap action of the figure-4 linkage having comparatively little motion from one frame to the next.

High-speed movies show that a sprinkler works in 1/10th second

Slower United States Recovery

LIGHT is thrown on world recovery in a recent issue of the *Business Bulletin* published by the Cleveland Trust Company and edited by Colonel Leonard P. Ayres.

"In June of 1933," according to the Bulletin, "when the Recovery Act went into effect, the volume of industrial production, as measured by the index of the Federal Reserve Board, was 92. This means that it was 92 percent as great as the average of production during the three years 1923, 1924, and 1925. Since that time there have been three periods of recovery, and three of decline, the latest of which is now under way."

The Bulletin then carries a tabulation compiled from statistical reports of the League of Nations to show the percentage recovery of a number of countries of the world from June 1933 to the spring of 1935. This tabulation follows:

Sweden	+41	Canada	+17
Hungary	+33	Finland	+14
Italy	+31	Austria	+10
Germany	+26	Poland	+8
Chile	+24	Czechoslovakia	+8
United Kingdom	+20	Netherlands	0
Russia	+19	Norway	—1
Roumania	+19	Belgium	—3
Japan	+17	United States	-9
Greece	+17	France	-16

The very low position in this scale of the United States is symbolized by, among other things, the production of steel. "In the United States the output in 1934 was 51 percent of that in 1928, but in the rest of the world it was 97 percent. . . . Figures for pig iron are available to show in 1934 a recovery here to 43 percent and abroad to 93 percent."

Thumb-Sucking Dangers Are Illusory

IF your child develops badly shaped jawbones, and in consequence has not the facial beauty you would desire for him, do not blame the thumb-sucking habit, if that is one of his faults. Thumb-sucking is not necessarily connected with deformities of the dental arches, Dr. Weston A. Price, Cleveland dental surgeon, recently stated at a meeting of the American Association of Physical Anthropologists. He studied primitive peoples from all over the world—Eskimos, Canadian Indians, Gaels of the outermost islands off the coast of Scotland—and found that, so long as they remained on their native diets, their children all had normal development of teeth and jaws, even though they did suck their fingers. But after contact with the outer world and the introduction of "store food," jaw and tooth troubles began.—*Science Service*.

Sponge Rubber Tires

SPONGE rubber is gradually being adapted to more and more uses. First it was introduced in rubber balls for children. Later excellent bath sponges, chair cushions, window channel guides, and so on, were developed. Now we find it in a dozen different places in automobile interiors such

as in arm rests, straps, seat cushions, and other places.

One of the latest developments is the use of sponge rubber fillers in place of inner tubes in heavy duty tires for army trucks. A tire so assembled deflects the same as an inner tube and is of course absolutely puncture proof. Exhaustive tests in which the tire has been shot through with machine gun bullets were very satisfactory. On the basis of these tests, army trucks are now being equipped with sponge rubber fillers in place of inner tubes.

Anti Ants

According to Prof. F. Z. Hartzell, entomologist at the New York State Agricultural Experiment Station at Geneva, extermination of ants in lawns can best be accomplished by gassing the insect with carbon bisulfide. The best way to get the fumes of the carbon bisulfide into the ant colonies is to make small holes about 8 to 12 inches deep and 6 to 8 inches apart around and through the infested area in the lawn. In each of these openings, place one tablespoonful of carbon bisulfide and cover it immediately with soil. The treatment is made more effective by placing a wet blanket over the infested area for about four hours to confine the gas. Carbon bisulfide gas is heavier than air and will replace the air in the tunnels occupied by the adult ants and the immature stages of the insects, thus affecting a quick death. One treatment usually suffices as most of the adults will be killed, and the young, if not killed outright, cannot survive without the care of the adults.

It is not necessary to purchase highly refined carbon bisulfide, which is often quite expensive, the so-called "technical" grade being entirely satisfactory for the purpose. Carbon bisulfide is highly inflammable and should be handled and stored with just as much care as would be exercised with a similar amount of gasoline. Also, special precautions should be taken while working with this material to avoid close contact with a lighted pipe, cigarette, or cigar.

Detects Spurious Gems with Dry-Ice

If you're thinking of buying a diamond or pearl, take along a piece of dry-ice when you go to make the purchase. According to M. D. Walker, writing in *Nature*, genuine stones emit a rattle or squeak when touched with a piece of solid carbon dioxide. Counterfeits make no noise. In the same way, says the author, a quartz lens may be distinguished from a glass one.

2,000,000 Patents

Just 99 years ago, in 1836, the United States Patent Office began its present series of patents with the issuance of patent number 1. On April 30, 1935, patent number 2,000,000 was issued. Mr. Joseph Ledwinka, chief engineer of the Edward G. Budd Manufacturing Company, was the patentee and his patent covered a pneumatic tire for railroad cars.

Mr. Ledwinka's own experience with patents serves to indicate the remarkable growth in the number of patents issued yearly. In all, he has been granted 248 patents. His first, in 1899, was number 638,643. Thus 63 years were required to issue less than three quarters of a million U. S. patents while during the past 36 years more than one million and a quarter have been issued.

Novel Refrigerant

Boron trichloride is receiving attention as a refrigerant in compression refrigerating machines. Added to its advantages of non-combustibility, non-toxicity, and absence of corrosion effects, is the further advantage that leaks in the refrigeration system may be detected immediately because the substance forms a mist when it comes in contact with moist air.—*A. E. B.*

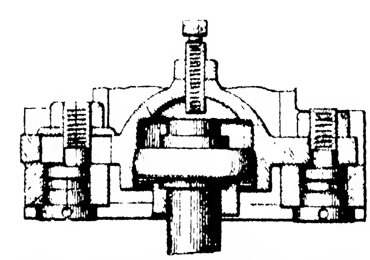
Variable Coupling Air-Tuned Radio Transformers

A new unit for superheterodyne radio receivers consists of a variable coupling air-tuned intermediate frequency transformer which provides a continuous range of variation from one-third critical coupling to over three times critical coupling. Continuous variation between these limits may be controlled from the receiver panel by means of an ingenious mechanical arrangement developed by Hammarlund. Where continuous variation is not necessary, the coupling may be adjusted to the desired value and locked at that point by means of a collar and set screw provided for that purpose.

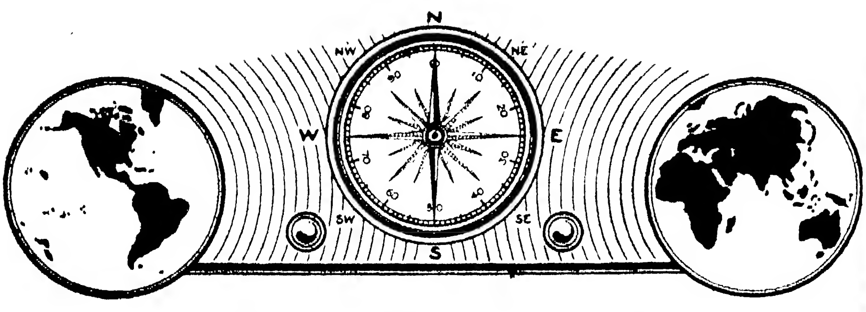
Both the primary and secondary are thoroughly impregnated three-pie Litz windings. The tuning condensers are the familiar midget air-dielectric type and are located on the sides of the shielding can at top and bottom. The transformers may be used with any screen grid tubes normally used as I. F. amplifiers. Both tuning adjustments are on one side of an aluminum shield.

New Adjustable Bearing Box

A patent for a newly invented bearing box which is universally adjustable has just been granted to Mr. William T. Harding of North Carolina. It is adaptable to certain cotton mill machinery for which it was particularly developed. The new bearing is capable of compensatory action when making certain vertical, horizontal, or longitudinal adjustments and is self-aligning. The saw cylinder of a saw gin using this bearing, for example, may be adjusted in all directions in respect to the grate and circular brushes with which it co-operates. Although more particularly adapted to cotton gins, it is applicable to any mechanical construction wherein the necessity of adjustment of one part to another arises.



New universally adjustable bearing



WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN*

Receiver Noise Reduction

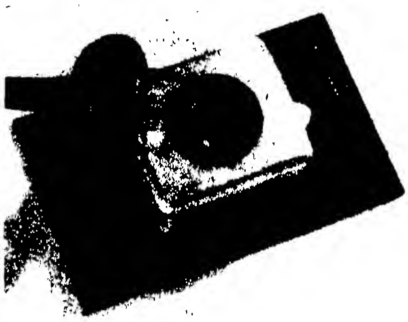
ANY type of radio receiver is subject to two distinct types of noise interference: natural static, which is a basic atmospheric disturbance, and "man-made" interference, produced by various forms of electrical machinery.

There is no cure for natural static, but, fortunately, this form of interference to radio reception is severe only during electrical storms and, in southern climates, during intervals of intense atmospheric changes. In any event, the effect of natural static on radio reception in general has been reduced to an almost imperceptible degree by the expedient of increasing the power of broadcast transmitting stations. The result is that the broadcast signals are of sufficient strength to "over-ride" the natural static and thereby create an impression of low static disturbance.

In the quest for radio programs free from natural disturbances, keep in mind the fact that the many small contrivances sold as "static eliminators" neither eliminate natural static nor reduce it to any degree without also reducing the strength of the received signal. The recent announcements with regard to a method devised by Major Edwin H. Armstrong of eliminating natural static had reference to a new *system* of transmitting and receiving radio waves, and therefore has no bearing on the foregoing statement.

Man-made interference, created by vacuum cleaners, electric fans, heating pads, leaky electric power lines, automobile ignition systems, and so on, may be reduced or completely eliminated, depending upon the method of attack. The noise may be eliminated at its source, or reduced to a negligible quantity at the radio receiver. Attacking the noise at its source is not always practical; firstly, the offending machine may be the property of a neighbor not disposed toward co-operation or, secondly, it may be difficult to trace. Moreover, it may prove expensive to treat all the electrical equipment in one's own home. Under ordinary circumstances, it is more practical to quench the noise of the arch offenders, such as oil burners and electric pumps, and disregard the small fry, such as sewing machines and vacuum cleaners.

In order to correct noise difficulties, it is necessary to have some understanding of the character of the interference. Natural static produces crackling, rustling, crashing, or grinding sounds, and is sporadic. Man-made interference more often than not has a sound characteristic of the machine producing it. Therefore, it is seldom sporadic and has some definite rhythmic tempo, and in instances where it is produced by some form of electric motor, may well have a decided musical pitch. As examples: A vacuum cleaner produces a sound in the radio receiver quite similar to the mechanical sound of the cleaner; a sewing machine produces a high-pitched and non-too-steady whirr; a dial telephone reproduces a series of equally-spaced clicks, the number of them corresponding to the digit dialed; the ignition system of an automobile is somewhat



Courtesy Aerovox Corp.

Figure 1: **Radio noise filter**

similar in sound to that of a dial phone except that the clicks are continuous and vary in their number per second with a variation in the speed of the motor. Moreover, the amplitude of the sound first increases and then diminishes as the car passes by.

The noise from any stationary electrical device may reach the radio receiver by one or both of two paths — either directly through the electric light wires, or by radiation through space, in which case the noise is collected by the radio antenna in the same way that the signals from a broadcast station are collected. There is the possibility, therefore, that the radio receiver will have to be protected against noise from two directions. If the receiver is of modern construction, more than likely the power-plug end is protected by a static screen against any noise that would ordinarily reach the set through the electric light wires. Receivers of earlier design may require a noise filter. One such device is illustrated in Figure 1. It is attached directly to the wall outlet and has a receptacle of its own for accommodating the power plug of the radio receiver. Oddly enough, the same sort of device, but with

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

a slightly different mechanical form, is used for the purpose of eliminating noise at its source. These devices are so constructed that they may be easily attached to vacuum cleaners and other household electrical equipment. Either type may be purchased from any radio dealer, or installed by a radio serviceman.

The task of eliminating man-made noise produced by oil burners, electric pumps,

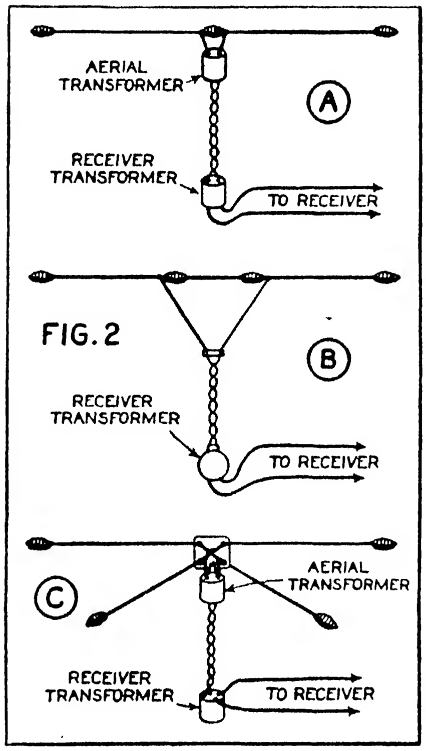


Figure 2: **Noise reducing aerials**

and other similar types of power machinery, should be left to a competent radio technician or an engineer from the local electric light company. These men have special equipment for tracing noise and can readily judge the size and complexity of the filter required on power machinery.

Stopping noise at its source is the most effective means of obtaining radio reception free of interference. Nevertheless, remarkable relief may be obtained by the use of a noise-reducing antenna system. This type of antenna is particularly effective when used in conjunction with a short-wave or an all-wave receiver. As a matter of fact, it is folly to expect satisfactory results from these receivers with an ordinary aerial.

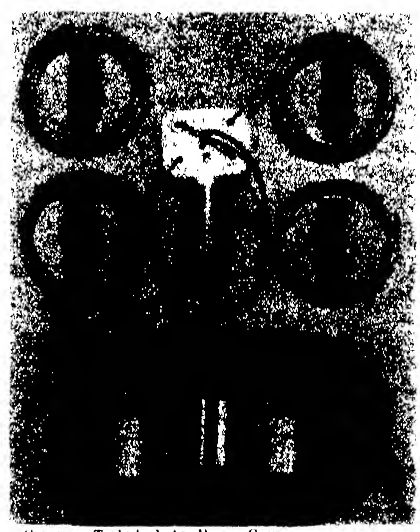
There are two basic types of noise-reducing antenna systems; one for use with a standard broadcast receiver and the other for use with a short-wave or all-wave receiver. The two types are not interchangeable, although the all-wave type may be used with a standard broadcast-band receiver since it is designed to operate effectively in all bands. It is just as well to use this type, for in that event, a perfect antenna system is available for an all-wave receiver when one is purchased.

There are as many all-wave, noise-reducing antenna systems as there are makes of radio receivers. Basically, they are all alike, and one make should function as well as another, provided it is the product of a reliable manufacturer.

The mechanical features of the various types are shown in Figure 2. The aerial shown at A is known as a "doublet" and consists of two horizontal wires of equal length insulated from each other at the center. Here there are attached two lead-in wires twisted together. At each end of the lead-in wires are connected "transformers." The upper or aerial transformer matches the electrical characteristics of the aerial to that of the lead-in; the lower or receiver transformer matches the electrical characteristics of the lead-in to those of the radio receiver input.

At B in Figure 2 is shown a similar type of antenna, but minus the aerial transformer. Matching in this case is obtained by fanning out the upper ends of the two lead-in wires. This type is equally as good as that shown at A. The only difference lies in the manner of obtaining what is known as the "impedance match."

At C in Figure 2 is shown a "double-doublet" antenna system. This is the most advanced type of all-wave, noise-reducing aerial, and is the most desirable form to use. The mechanical shape is not always exactly as shown in the illustration, but, in any case, there are *two* sets of wires rather than one set. The wires of the additional set are of equal length, but shorter than the horizontal set. The longer wires are effective at the longer wavelengths and the shorter wires at the shorter wavelengths. The dimensions of both sets of wires are such that almost equal response is obtained at all the wavelengths covered by the average all-wave receiver. It should be mentioned here that the type of antenna system shown at B in Figure 2 is



Courtesy Technical Appliance Corp.

Figure 3: **"Double-doublet" kit**

also of the "double-doublet" type. The fanned-out lead-in wires serve as the second and smaller doublet.

A typical "double-doublet" antenna kit is shown in Figure 3. The uppermost coils of wire are the long, horizontal doublets; the lower coils are the shorter doublets which are usually erected at an angle with the horizontal. At the center of the coils of wire is shown the dividing insulator and, attached to it, the aerial transformer. The large coil of wire at the bottom of the illustration is the twisted pair lead-in. In the center of this coil is shown the receiver transformer.

Any of these all-wave, noise-reducing antenna systems may be installed from directions obtained with the kits. Here

again, however, it is best to have the installation made by a competent radio technician. There are a number of technical factors which must be taken into consideration. The mere erection of such an aerial system in what may appear the most suitable space is no guarantee that the aerial will function properly. But, if you wish to handle the installation yourself, here are a few pointers:

Normally, man-made interference hugs the ground. Therefore, the higher the aerial, the less will be the noise pickup.

In the case of apartment buildings, and other structures having steel beams and a large amount of metal piping, the "ground" is the roof of the building. Therefore, erect the aerial at least 20 feet above the roof or—if possible—string the aerial from the edge of the roof to a nearby tree, pole, or the roof of another house.

Do not erect the aerial near any metal structures. Metal roofs, metal pipes, steel beams, light and telephone wires, and so on, will pick up noise from electrical machinery and *re-radiate* it. Thus, if the aerial wire is near any such metal object, it may pick up noise originating in the cellar of the building or in the house next door.

Do not permit the aerial wires to run parallel to electric light or power lines. Place the aerial at right angles to such lines, or as near a right angle as possible.

Do not fasten one end of the aerial to the top of an elevator shaft. These shafts are a prolific source of interference. If necessary, add rope to the end insulator so that the aerial wire itself is at least 20 feet from the shaft.

Do not worry about the lead-in wire. This may be run directly through a noise area. Any noise picked up by the lead-in is balanced out before it reaches the radio receiver.

Doublet and double-doublet antenna systems have slight directional characteristics. They receive best from directions at right angles to the horizontal stretch. Therefore, if the ends of the wire point north and south, best reception will be obtained from the east and west. Likewise, if the ends point toward noise sources, the interference will be minimized.

CURRENT BULLETIN BRIEFS

A GUIDE TO BETTER ALL-WAVE RECEPTION includes descriptions of the latest forms of double-doublet and single-doublet all-wave noiseless antenna systems. Other helps to the all-wave reception fan are also described. *Write for Bulletin 835A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

WORLD SHORT-WAVE RADIOPHONE TRANSMITTERS, compiled from official and unofficial listings by Lawrence D. Batson. The preparation of a comprehensive list of short-wave transmitters of the world is a large undertaking, complicated by the fact that stations are constantly being constructed and rebuilt. This listing, however, is one of the most complete available and is to be recommended to all short-wave enthusiasts. It includes several valuable charts, a world time map, and lists stations both geographically and by wavelength. Contains other pertinent information. *Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.—25 cents (coin).*

S. A. E. STANDARDIZATION ACTIVITIES: A REPORT TO THE PRESIDENT AND COUNCIL, by C. W. Spicer. An important work for industry is being done by the Standards Committee of the Society of Automotive Engineers. The present pamphlet outlines the general policy and procedure of the Standards Committee and contains an index giving references to specific recommendations for standard practices. *Society of Automotive Engineers, Inc., 29 West 39th Street, New York City—Gratis.*

FROM THE ROUGE TO THE ROAD is a remarkable little booklet, thoroughly illustrated with unusual photographs, which tells a running story of the huge multi-angle industry which has been built up around the production of motor cars. The booklet is printed in two colors and will be of interest to anyone who drives an automobile. *Write for Bulletin 835B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

ACCIDENT FACTS. The modern juggernaut of accidents claimed more victims in 1934 than ever before. This booklet tells the tragic story so that each one who reads will be better prepared to avoid accidents himself and to help others live safely. Illustrated with comprehensive charts which drive home most forcefully the causes of accidents of all types. *National Safety Council Inc., 20 North Wacker Drive, Chicago, Illinois.—Single copies 50 cents each; less in quantities.*

188 BOAT BUILDERS AND WHAT THEY BUILD is a large folded chart listing builders of all types of outboard-powered boats from canoes and rowboats through racing boats, to outboard cruisers. Mention is also made of companies supplying plans for building boats. One of the most complete lists of its type that we have ever seen. *Write for Bulletin 835C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

PER CAPITA COSTS IN CITY SCHOOLS, 1933-34, Pamphlet No. 61, by Lula Mae Comstock. This publication is the result of a carefully conducted survey of various groups of city schools. It includes a tabulation of the cities surveyed, listing population, daily current expense, yearly current expense, and other pertinent data. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

A NEW CROCODILE FROM THE PHILIPPINE ISLANDS, by Karl P. Schmidt, is a four-page pamphlet that is Volume XX, No. 8 of a zoological series. The leaflet describes a salt-water crocodile, *Crocodylus porosus*, which is found in most sections of the East Indies. Illustrated with two drawings showing palatal views of skulls of crocodiles. *Field Museum of Natural History, Chicago, Illinois.—10 cents.*

Books SELECTED BY THE EDITORS

THE SEARCH FOR TRUTH

By Eric Temple Bell

WHAT is truth? What is straight, sane thinking? Both are rarely attained, most of our thinking being of the wishful kind—unconsciously we believe what we wish were true. This book centers around the rules of thinking employed in man's search for truth—rules which underlie all scientific theories. A difficulty in the way of radical advances in thinking is our inability, the author says, to throw off traditional patterns of reasoning which we have acquired through years of hard work at school. But this book is no dry discussion about logic; it is bright, witty, often ironical and sarcastic, and has been received with amused approval by many scientists. The author is a well-known mathematician and his book shows the mathematical (logical) type of mind at work, but it is not in the least mathematical. He analyzes scientific theories, picks on half-baked thinking and especially on mystics. (If you are a mystic this book will spoil your digestion, but if you are a realist it will cure dyspepsia.) He has "a trenchant style, a caustic pen and a rich sense of humor."—R. W. Porter. He places sharp tacks in the seats of the mighty of the scientific world, respects no sacred cows, and reveals plentiful cat-holes, even in Euclid's and Aristotle's "watertight" logic, likewise some modern mystics', including Eddington's and Jeans'. A few topics: Toward Cloudcoocooland; Monkeying with Time; Science and Religiosity; False Gods; The Fourth Dimension; The Priesthood of Science. All persons interested in scientific theories should read this outstanding work.—$2.65 postpaid.—*A. G. I.*

A HISTORY OF THE GREAT WAR

By C. R. M. F. Cruttwell

A LARGE part of the books about the World War have been partisan—if not pro-Ally or pro-German, then at least pro-some-statesman-or-other, or pro some general, or warped in some single direction. But no book about the War has received so much praise on one score—its objectivity—from reviewers and critics as this one, written by an Englishman. Without heat or spleen he dispassionately points out both the faults and merits of either side, yet his account makes fascinating reading, like a narrative—which it mainly is. It leans rather more toward the technical military side—in other words it is not superficial—but any non-military reader would find it easy to follow.—$5.70 postpaid.—*A. G. I.*

SEISMOGRAPHING FOR OIL

By E. G. McKinney

INSTRUCTIONS for doing the field work in connection with prospecting geophysically for oil by the seismic (artificial "earthquake") method. A practical 38-page booklet.—$2.15 postpaid.—*A. G. I.*

WHY THE WEATHER?

By Charles F. Brooks, Professor of Meteorology, Harvard

THIS is a revised and enlarged edition of a book published in 1924, which deserved a big sale and got it. It is the outgrowth of daily explanations of the weather to classes in meteorology. Its 29 chapters provide enough weather wisdom to equip a man to do his own weather thinking. The style is popular, not text-bookish.—$2.65 postpaid.—*A. G. I.*

MODERN GAS AND ELECTRIC REFRIGERATION

By A. D. Althouse, B.S., and Carl H. Turnquist

IN this book there are given first the fundamentals of refrigeration. Following this comes discussion of various types of electrical and gas refrigerators, together with well drawn diagrams and color plates showing their operation and the circulation of the various chemicals that are used. It seems to cover about all the better known units in such a detailed fashion that the student may learn the essential principles without difficulty.—$4.20 postpaid.—*F. D. M.*

THE FUNDAMENTALS OF RADIO

By R. R. Ramsey, Ph. D., Professor of Physics, Indiana University

THE first edition of this valuable text book appeared in 1929. Now the second edition has been published, bringing the whole subject thoroughly up to date. The book was written as an elementary text for college students but it can be read with profit by anyone who has a fair background knowledge of electricity and elementary mathematics. True, the author introduces calculus in a few places but the reader who is not familiar with this phase of mathematics can pick and choose. The text is thorough-going, from an explanation of direct and alternating currents right straight through to the very latest types of multi-element vacuum tubes and television. This is not in any sense a "how to make it" book or a compilation of various "hook-ups." Rather it is a solid, meaty exposition of the principles underlying the many phases of radio. 426 pages, well illustrated, and printed on good paper.—$3.50 postpaid.—*A. P. P.*

SCIENCE AND THE HUMAN TEMPERAMENT

By Erwin Schrödinger

THE notable Austrian physicist who developed de Broglie's electron wave theory into a famous theory of wave mechanics, and possibly replaced the law of cause and effect with a statistical law, is the author of this book. The attempt by Schrödinger and others to smash the law of causality has provided a loophole for the mystics to escape from a strict cause and effect world, yet retain their scientific outlook, also to attempt a reconciliation of religion with science. Indeed, the ranks of science have provided some of the same mystics, notably Eddington and Jeans. All this leads away from realism, for the last building stones of the universe are thus reduced—so this book says—to "a spiritual throb" and are nothing but pure thought.

Many men of science who are not mystics regard this latest philosophical excursion of a few of their members who are mystics, as a variety of aberration, but it has had wide repercussions among the public, and this book explains it in a very clear, popular though not too popular manner, with added interest due to the fact that the explanation is by one of the "big shots" who developed the famous concept.—$2.65 postpaid.—*A. G. I.*

WILD BIRDS AT HOME

By Francis Hobart Herrick

IF for no other reason than for the enjoyment of dozens of unusual photographs, this book is certainly well worth possessing. The index lists 137 illustrations, the large majority of which

are photographs taken by the author. Many of them show various birds in action and in various stages of growth. Birds' nests of different types receive an adequate amount of attention. But the illustrations are by no means the whole book. In 345 pages, including a comprehensive index and an explanatory appendix, the author presents a popular study of wild birds, chiefly concerned with those activities which center in the homes or nests of different species. A short description is given of how the author obtained some of the more unusual photographs, and the appendix reviews in more detail the equipment employed. Every nature student and bird lover will be proud to own a copy of this comprehensive book.—$4.20 postpaid.—*A. P. P.*

BUILDING YOUR LIFE

By M. E. Bennett

THIS book is full of advice on self-analysis, and is intended mainly to help persons of high school and college age to plan their lives most effectively. Its author is Director of Orientation in the Pasadena Junior College, and Director of Guidance in the city schools of Pasadena. His book is filled with very practical matter on the analysis of one's own traits, and on the elimination of one's faults and becoming adjusted to life as it is lived here on this odd planet, rather than to the mere generalities and platitudes so often found in such books. If that young man or young lady whom you know seems to be aimlessly drifting, this book ought to provide a chart and compass—and it wouldn't greatly harm some of us old folk to read it, either.—$2.65 postpaid.—*A. G. I.*

THE FRONTIERS OF PSYCHOLOGY

By William McDougall

IN this book a famous psychologist discusses many subjects which lie in the space *between* psychology and the other sciences, notably physics. Essentially this is a book on the philosophy of science, and it will be understood by those who have previously given that subject some attention. It is very compact and discusses all the various schools of thought and theory.—$2.15 postpaid.—*A. G. I.*

MAN'S CONTROL OF HIS ENVIRONMENT

By Powers, Neuner and Bruner

THIS is a 750-page, illustrated textbook of general science, for use in junior high school grades—7th, 8th, and 9th. It covers all the sciences and shows—by its striking contrast to the inadequate teaching of science in the schools of a generation ago—why it is so hard for persons belonging to that generation to keep up with youngsters in the modern schools, in general background knowledge of science.—$1.80 postpaid.—*A. G. I.*

BOTANY

By Edmund W. Sinnott, Professor Botany, Barnard College

THIS is a straight, modern college text-book of elementary botany, without attempt at popularizing, but it is an unusual one because it emphasizes strongly the interpretation and significance of the facts set forth. It has 508 pages and 310 figures, is splendidly produced and ruggedly bound.—$3.70 postpaid.—*A. G. I.*

INFRA-RED PHOTOGRAPHY

By S. O. Rawling, D. Sc., F.R.P.S.

TO anyone who is interested in taking infra-red photographs, and really understanding what he is doing, this little book will be a find. It is an ideal book—a model book—because it is practical. It anticipates the reader's difficulties, answers his questions in advance, and even tells what materials to use and where to get them. It also understandably explains the principles of physical optics underlying its subject. The author is both a physicist and an amateur photographer—perhaps this is why he was able to prepare so good a book on this scientific corner of a hobby.—$1.65 postpaid.—*A. G. I.*

THE NEW INTERNATIONAL YEAR BOOK

Edited by Frank H. Vizetelly, Litt. D., LL.D.

"A COMPENDIUM of the world's progress for the year 1934," does not do full justice to this extraordinary book. It is a collection of discussions by scores of authorities on the history that was made during the last momentous year. It is, in fact, an encyclopedia of the year's doings compressed into 761 pages, well illustrated, and in alphabetical order so that a discussion of practically any subject may be found at once.—$6.50 postpaid.—*F. D. M.*

PSYCHO-ANALYSIS FOR TEACHERS AND PARENTS

By Anna Freud

THIS little book contains a series of four lectures entitled respectively "Infantile Amnesia and the Oedipus Complex," "The Infantile Instinct-life," "The Latency Period," and "The Relation between Psycho-analysis and Pedagogy," which were given by the daughter of the famous Sigmund Freud who put psychoanalysis on the map. It is a simple introduction to the Freudian kind of psycho-analysis.—$1.90 postpaid.—*A. G. I.*

ASTRONOMICAL SOCIETY OF THE PACIFIC—LEAFLETS

MUCH meaty matter is compacted into the 206 pocket-sized pages of this book. It is a reprint of 50 leaflets that have appeared serially since 1925. Each is a solid summary of a single topic in current astronomy, written by some able astronomer. For example: Island Universes; Jupiter; Polaris; Weighing the Stars; Lunar Temperatures; Dark Nebulae; and so on. Illustrated, nicely produced. A little gem of a book.—$2.40 postpaid.—*A. G. I.*

RESEARCH

By T. A. Boyd, Research Division General Motors Corporation

A BOOK for those who think of going into research, or of adding a research staff to their industries. It provides background about method, men, qualifications and achievement. The author tells clearly and simply "what this research business is all about." The chapter entitled "Dividends" will pull perhaps hardest.—$2.65 postpaid.—*A. G. I.*

AIR CONDITIONING (WITH OZONE FACTS)

By E. W. Riesbeck, M.E.

THIS is an easily understandable discussion of the various types of air-conditioning units, together with technical data as to their construction, operation, and servicing. Ozone—its history and practical applications, particularly in the sterilization and purification of water—is discussed in a rather large section of the book.—$3.70 postpaid.—*F. D. M.*

THE HOME-MADE TELESCOPE

By W. F. Decker, M. E.

THIS book was written to help high-school lads of pre-geometry age to make a simple, non-paraboloidal reflecting telescope with pipe fitting mounting. Adapting his treatment to the average capability of the readers at whom he aims it (not at the occasional precocious lad) the author purposely, and no doubt wisely, cuts many corners and omits many counsels of perfection. A neat little book.—60 cents postpaid.—*A. G. I.*

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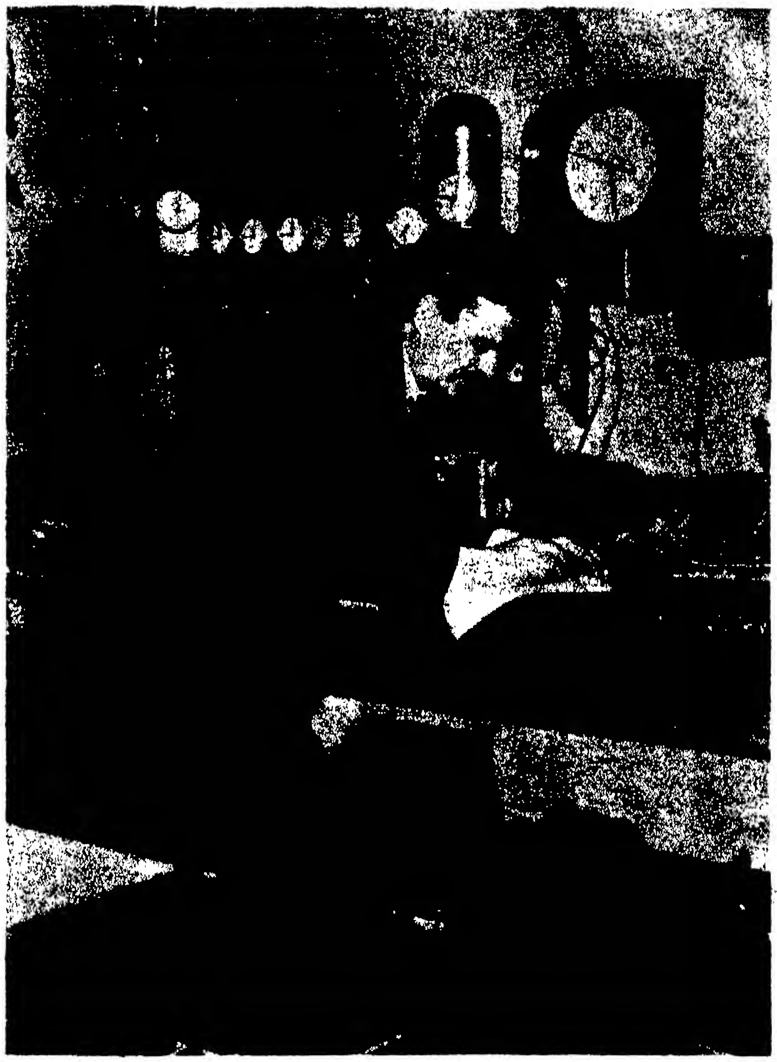
Personalities in Science



HENRY ELLIS WARREN

HENRY ELLIS WARREN, president of the Warren Telechron Company, Ashland, Massachusetts, who received the John Price Wetherill Medal last May from the Franklin Institute in Philadelphia in recognition of his invention of the Telechron motor—a small, limited-power, self-starting, synchronous motor having strong starting torque and synchronous torque characteristics—was also presented the Lamme Medal at Cornell University during the summer convention of the American Institute of Electrical Engineers, in June.

The John Price Wetherill Medal is awarded to individuals every year who have discovered or invented something in the field of physical science, or who have made new or important combinations of principles or methods already known. The Lamme Medal of the American Institute of Electrical Engineers is given each year to a member of the institute "who has shown meritorious achievement in the development of electrical apparatus or machinery."

Mr. Warren was born in Boston, Massachusetts, May 21, 1872. He graduated from the Massachusetts Institute of Technology with the degree of S.B. In 1902 he became engineer and general superintendent of the Lombard Governor Company and made improvements in the design of hydraulic speed governors which were installed in many of the largest water-power plants of the United States. During the World War he designed several types of hydraulically operated machines which were used in the production of heavy shells. A new type of fire control mechanism was also developed by him at this time.

Settling on a farm in the town of Ashland, Massachusetts, he became seriously interested in designing and constructing various forms of electric clocks as an avocation. He used one of the farm buildings as a workshop which was the forerunner of the Warren Clock Company's factory. The Warren Clock Company was organized in 1912 to build and sell battery-operated clocks.

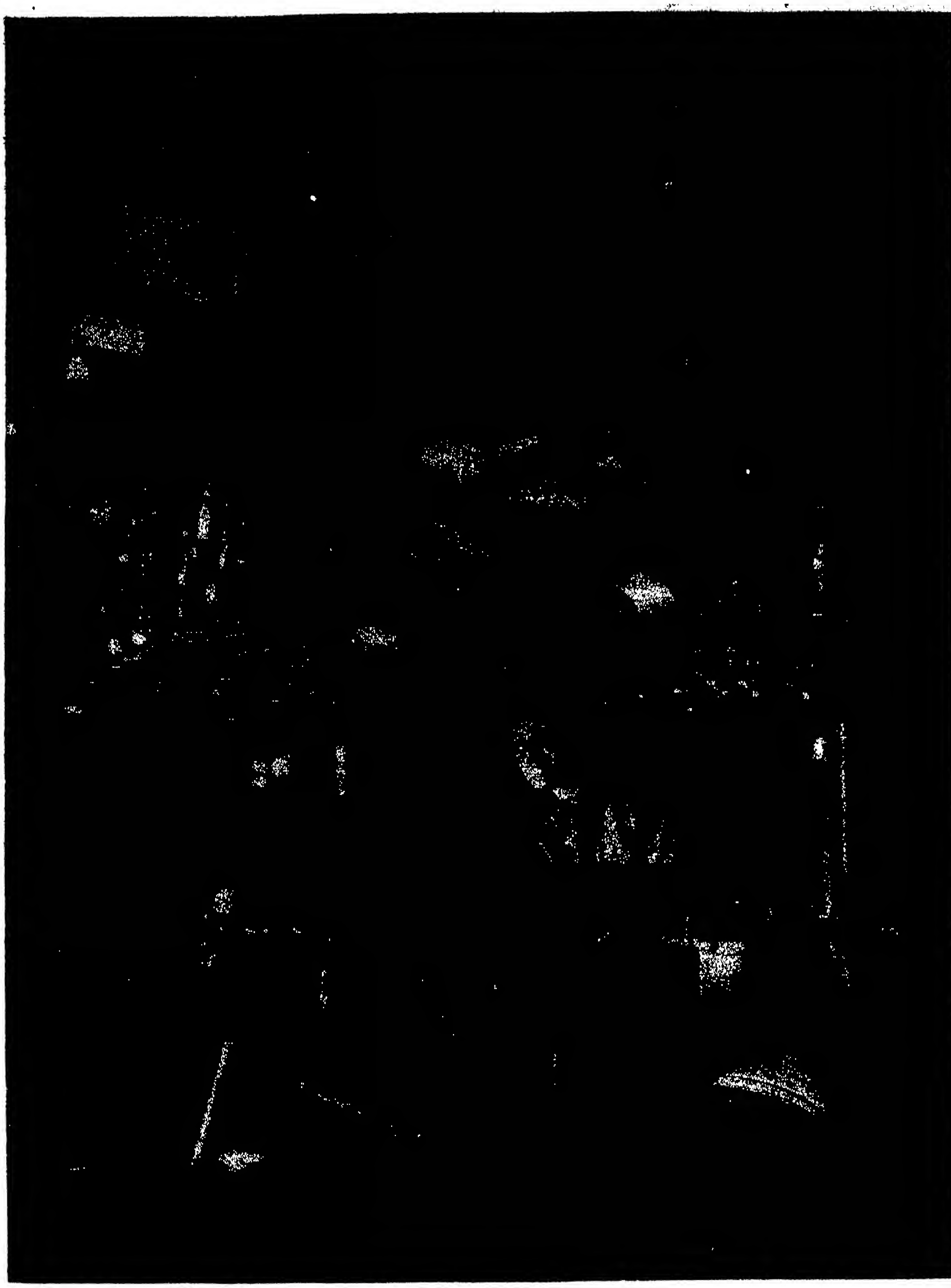
In 1916, Warren tackled the problem of utilizing commercial alternating current for the purpose of time-keeping. It was necessary to invent a new form of self-starting synchronous motor which would be adaptable for use in clocks under different conditions from those to which ordinary power motors are subjected. Next, it was necessary to perfect an instrument for measuring frequency with great precision. This instrument later became known as the Warren Master Clock.

By the end of 1916, engineers of the leading power companies had been persuaded to use this instrument so that the frequency of alternating current might be controlled with sufficient accuracy.

The first to adopt the new method of frequency regulation by means of the master clock was the Edison Electric Illuminating Company of Boston. Within ten years the use of the regulated alternating current as a new kind of time service became general. As a result, the proportion of electric clocks to all clocks exclusive of alarm clocks produced and sold annually has risen from less than 2 percent in 1916 to more than 60 percent in 1933, with the increase steadily climbing.

Mr. Warren has been engaged since 1916 in adapting time-keeping synchronous motors to many fields of usefulness and in providing improved devices for frequency control. More than 100 patents have been granted to him. During the past 15 years he has served as president of the Warren Telechron Company and consulting engineer for the General Electric Company.

Among various technical papers by Warren are: "Clocks in the Field of Electric-Light Appliances"—Proceedings of the National Electric Light Association, 1917; "Utilizing the Time Characteristics of Alternating Current"—Transactions of the American Institute of Electrical Engineers, 1919; "Synchronous Electric Time Service," the same, 1932.



HYDRAULICS AND ELECTRICITY MAKE BETTER AUTOMOBILE BODIES

FIFTY contacts are made, one after the other, with lightning-like rapidity, as this hydraulically operated spot welder joins the metal dash to the outer shell of the steel front-end assembly in the production of "turret top" automobile bodies. Oil under regulated pressure clamps the welding electrodes to the exact spots where the welds are to be made, and an electrical timing device supplies the correct current for the proper length of time to first one and then another of the electrodes in rapid succession. In the photograph, the electrodes are lifted clear of the work, which shows directly below them.

Courtesy More Game Birds in America—A Foundation

Scenes such as this, once frequent but now rare, can again become part of the picture of American wildlife

SAVE OUR GAME!

Provide Reservations . . . Stop Useless Swamp Drainage . . . Game Conservation Has Wide-Spread Effects . . . Value to Communities and Individuals

By J. N. DARLING

Chief, Bureau of Biological Survey, Department of Agriculture

ONE of the inconsistencies of American behavior that will puzzle future students of our present era will be that we show an intense interest in our national wealth and an astonishing lack of it in the natural resources which produce wealth.

It required 300 years and a Theodore Roosevelt to make Americans realize that the wanton destruction of our forests then proceeding apace would be followed by conditions far more disastrous than defeat in war by a major power. The indifference with which we regard the exploitation and waste of our exhaustible resources of oil and coal is tragic, and any promoter or politician can do about as he wishes with our water resources, draining and damming without concern for effects on vitally important water levels of the country. The prod of a mosquito's "harpoon," admittedly irritating and sometimes dangerous, is enough to convince us that, after all, the ocean is the only proper place for water, and to set us at work draining every slough and pot hole and marsh into the sea. Dust storms, still a novel phenomenon in agricultural United States, are the first comparatively mild warnings of what to expect when an overconfident civilization attempts to set nature right on the matters of water and forest reserves.

Our native wildlife is one of the most valuable of the nation's resources, and it is certainly the most neglected of them. Yet even in its present diminished state the annual income from all its forms probably amounts to around a billion dollars. Not alone, of course, in the market values of fish, flesh, and peltry, but in wages paid for labor, in the value of farm crops saved by insectivorous birds, in land rentals, in profits to transportation companies, farmers, the hotel business, to merchants and manufacturers, publishers and printers—to name a few—and in taxes that help support the Federal and State governments.

BUT we have persisted in the notion that our fishes, animals, and birds were invested with some miraculous Providential dispensation that would enable them to take care of themselves regardless of abuse, and this charmingly naïve sentiment has nearly wrecked the resource. In half a day at any gathering of people particularly interested in the subject of American game, one can hear advanced with complete assurance in each case a score or more of causes why the resource has declined in two centuries from incredible abundance to its present attenuated state. The causes will range all the way from the predatory habits of the glaucous-winged gull to the position of the spots on the sun. And most of them will have some bearing on the truth, as a matter of

Courtesy Wisconsin Conservation Department

Winter feeding does much to conserve game. Here are sharp-tailed grouse at a typical feeding station

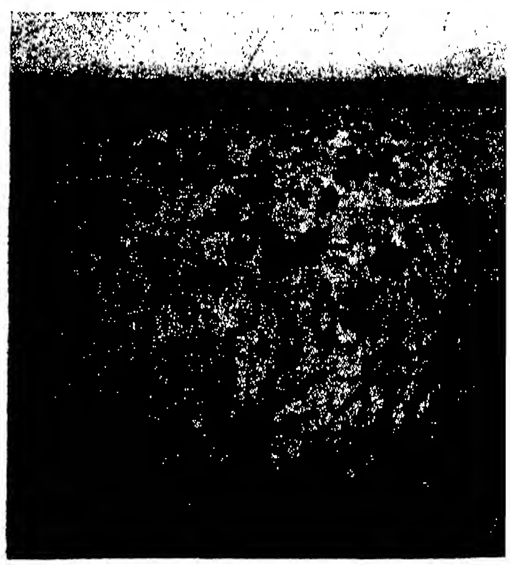
fact! But it seems to me that our present distress is caused by our neglect of two matters of fundamental importance, and it may be alleviated and perhaps cured completely by remedying (1) our land utilization policies of the past—if one can so describe a non-existent thing—and (2) by adopting a more matter-of-fact and businesslike attitude toward our wildlife. There is still time to repent and to drive the unscrupulous politicians, game hogs, and fanatics back from the struggling victim.

WILDLIFE is a crop and like any other it must have land to grow on. The restoration of wildlife is therefore first of all a land utilization problem. Not even the most enthusiastic zoophile could insist that all the cattle and sheep be run off the western ranges so that the bison, elk, and antelope could have the freedom of their ancient domain restored, or that the rich farm lands of the central United States be allowed to revert to nature for the benefit of quail, deer, turkey, and rabbits; the modern lesson we are striving to learn is that in our two billion acres of terrain there is land sufficient to every use of industry, agriculture, and wildlife. For example, the reservation of enough grazing lands to maintain a reasonable supply of our big game animals can be accomplished without infringing upon the reasonable requirements of the stock growers. The same is true of small game species. A few large reservations of the hereditary ranges, supplemented by the development for wildlife purposes of waste lands, of odds and ends such as ravines, sloughs, roadside strips, fence rows, and submarginal tracts, will be sufficient to bring back the wild creatures, even in our intensively cultivated areas, in more abundance than has been observed for two generations.

By resort to desperate measures we have managed to acquire land enough to preserve our game species from any immediate danger of extinction, but our operations in the past have of necessity had little or no reference to any grand basic plan for a land use scheme to include wildlife. We have, for example, a few herds of bison on Federal refuges. These animals were literally turned back from the very edge of extermination, and we can no doubt maintain them at their present numbers or even increase them, if lands should become available for restocking. We have the antelope, the mountain sheep, and the elk similarly cared for, but a visitor with a more than ordinary respect for the fitness of things and some reverence for American traditions, might find cause to wonder if our gestures in behalf of these original inhabitants have been so generous after all. It might be more chivalrous perhaps to fall upon these remnants with the rifle, than to condemn them to a meager and unnatural existence on the thin and unproductive parings of land so poor that we can't use it ourselves.

IN the Jackson Hole region of Wyoming a herd of 20,000 elk still manages to exist under such aid as the State and Federal government can give them. There are refuge lands set aside for the protection of the animals, and their summer pastures furnish ample food during the warm months. But there is not enough winter range in the valleys to which the herd must come when cold and snow force them down from the heights. Then we have the curiously depressing spectacle of the largest remnant of our American elk, the descendants of the great herds that once covered the continent from coast to coast, the most majestic of all the deer tribe, crowding for the "handouts" of hay and grain furnished by the State of Wyoming and the U. S. Government, and being chased from adjacent farm lands like strayed livestock. Perhaps others do not feel as I do about these things, but it sometimes seems to me that the cruelest act that mankind can commit against these wild creatures is to pervert them from their God-given wildness of spirit and force them into a state of half servile, wholly degrading tameness.

We have heard much in recent years about submarginal lands. These are the soil types lying midway between fertility and barrenness. They tempt the farmer to occupancy, but they produce, as a result of unremitting toil, only enough to keep him from starving to death and never enough to permit him to move away. On most of these lands fish, game, and furbearers can exist with far better profits to humanity than when given over to a desperate sort of agriculture. The Chinese have been notoriously industrious in the manufacture of submarginal land, and after countless centuries of draining and deforestation they have fairly well managed to turn an Eden into a desert. We Americans with our boasted energy and resourcefulness have made in our brief occupation of the land proportionately more progress than the Orientals. In witness whereof about 17,000,000 acres of water areas—sloughs, shallow lakes and ponds, marshes and bogs—have been drained in the north central states alone. Throughout the United States the total drained areas amount to more than



An ideal wildlife refuge such as will be made work will include impounding water by diking

110,000,000 acres. Some of these lands now fall within the submarginal classification, much is quite barren, and only an insignificant acreage has proved to be of value for agricultural purposes.

The value to a community of a sizeable shallow water area is not generally understood. If it breeds a few mosquitoes—as of course it does—the owners of adjacent properties forget that it also produces furbearers whose pelts bring many a dollar into the district, and fish and waterfowl. They probably do not realize that the local marsh protects local water levels and that it is one of nature's most effective engineering devices to prevent flood and soil erosion. The dismal dust storms which have been tormenting the northern states are born and "brought up," literally, within the great north central

region mentioned above, where the drainage shovel has exposed 17,000,000 acres of land once under water.

Soil wash and wind erosion do not make headway in a territory that supports an abundance of wildlife. The environment that attracts our native birds and beasts does not promote dust storms and floods. It might be said that the disappearance of native wildlife from a region is the first sign of bad land practice and the first warning of graver disasters to follow. The melancholy and laconic observation of the Indian watching a pioneer farmer plowing under the virgin sod of the prairie, "Wrong side up, white man," has too often been realized.

For these mistakes of the past there is only one sure corrective—a sound policy of land utilization with a definite place in the program to satisfy the needs of wildlife.

I mentioned at the outset of this article the American eccentricity that permits us to enjoy a serene confidence in the renewability and indestructibility of a billion dollar a year wildlife foundation. I do not know from whence this glorious bit of asinine assurance springs, but I suspect it is because the laws that govern the reproduction of most species of wildlife are little understood by the average man or woman. Wild ducks, or woodcock, or deer are creatures of mystery compared to domestic beasts or fowl, and it is difficult for many a man to realize that the wild blue goose nesting in the solitudes far up under the very fringe of the aurora borealis increases or decreases, thrives or starves, according to the same biological laws that control the tame white geese in the farmyard. Because of this it has taken us a long time to come to the point where we are willing to adopt a practical attitude toward our game and to endeavor to strike our balances in orderly fashion, as we do with our ducks and chickens or our financial nest eggs. More often than otherwise the game laws supposed to control expenditures of wildlife represent a compromise between the demands of those who wanted more restrictions and those who wanted less, and no one knows or cares whether there was an expendable surplus on hand or a dangerous deficit.

Let me give a single example from the many that occur to me. Ten years ago the state of Maine produced annually more mink pelts than are now being produced in the entire United States.

"What a frightful decrease!" someone exclaims.

Exactly, but more than that it is the evidence of bad business management and it should be a challenge to the modern wildlife technician, for we know now that, outside of normal seasonal fluctuations, such constant serious losses as are indicated in the mink population need not usually occur.

I believe that we are witnessing the beginning of the end of the doctrine of *laissez faire* as applied to wildlife conservation in this country and are ready to substitute a bookkeeping system for the old careless way and to exchange the divining rod prognostications of self elected or politically endowed wildlife authorities for the sober but wholesome facts dug up by trained game technicians. I hope so, anyway.

RECENTLY a leading American manufacturer of arms and ammunition set up an endowment fund of 30,000 dollars a year for five years, the money to be used for the restoration of valuable forms of wildlife. The gift was a voluntary one and carried no reservations except as indicated above. We may expect to hear the cry of "treason" raised in some quarters when this announcement is made, for there are still individuals interested in wildlife conservation who view with greatest alarm any attempt on the part of the manufacturers of sporting guns and ammunition to help our conservation agencies to solve the tremendous problems with which we are now confronted. They cannot believe that an industry that derives a portion of its profits from the sale of game-killing weapons can have any worthy motive behind its contributions. In past years such proffers have been regarded as thinly veiled bribes to obtain longer open shooting seasons, increased bag limits of game, and so on—measures that ostensibly, at least, would result in increased gun and ammunition sales. Perhaps in the years when game was still so abundant that only a few very observant men could note any decrease in its numbers there was a definite reluctance on the part of the industries associated with the sport of shooting to welcome restrictions on the gunner for which they saw no need. This was certainly true of a majority of the gunners themselves.

BUT the situation now is different. I know that this arms maker was strongly moved by sentiment when he offered to place 30,000 dollars a year for five years at the disposal of the Biological Survey for the purpose of teaching approved methods of wildlife restoration and administration in several of our state universities. He would be less intelligent than I know him to be if he failed to see that his endowment is also an investment for his company—one sure to bring increased profits in the years to come.

●

Advanced Amateur Photographers: Starting this month—"Camera Angles," a department devoted entirely to interesting and informative short articles on all phases of photography. Keep up-to-date in your hobby. See page 162 of this issue.—The Editor.

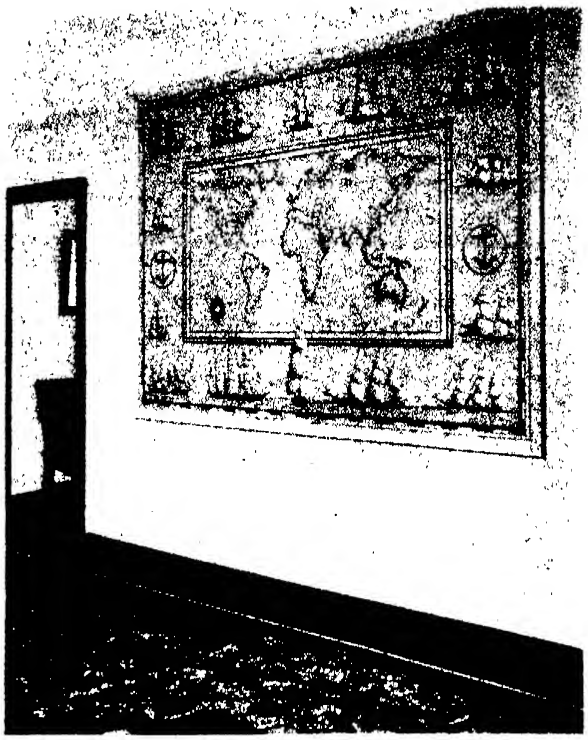
e under the Wildlife Restoration Program. The :hing, and the planting of attractive food plants

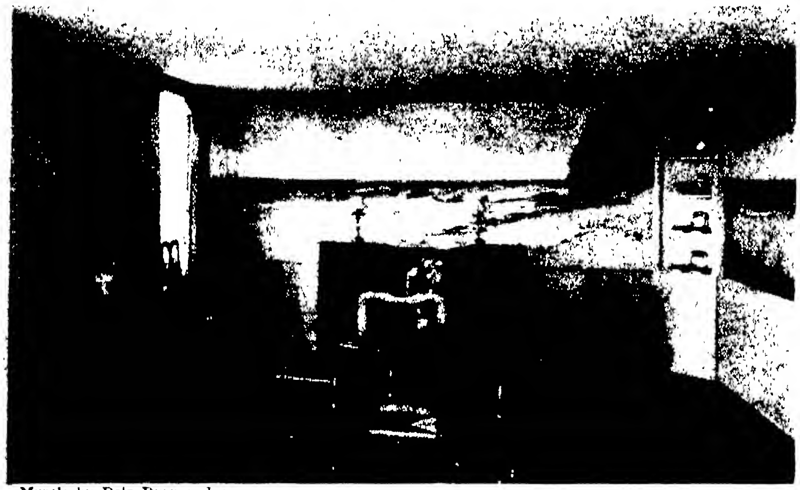
Courtesy Bureau of Biological Survey

The elk refuge at Jackson Hole, Wyoming, is one step in the right direction, but it is not enough. The elk living here do not have sufficient winter forage

Photo-Murals Gain Favor

Upper right: A mural map illustrating the history of the American merchant marine, in the office of a shipping company. *Below:* Murals in transparent oil colors, decorating the walls of a private residence, were made from snapshots taken by the owner. *Lower right:* Murals depicting the history and development of New York City. *Lower left:* The walls of an advertising agency's offices tell in photo-murals the story of their business





Murals by Drix Duryea, Inc

MURALS by photography offer a new form of wall decoration unlimited in its range of pictorial design. Through extensive research and experimental work in laboratories and projection rooms, photomurals have become a recognized process for the reproduction of any subject that can be seen with the human eye and some that can be rendered visible through the use of infra-red and X rays.

Photographic murals are usually produced on a specially sensitized rag paper. Where a fabric surface is required, sensitized canvas or heavy duck is used. The mural is usually composed of strips of material 40 to 50 inches wide, the length depending on the height of the mural. After the photographic illustration has been projected onto the sensitized surface and processed, the strips, which are numbered in sequence, may be assembled and hung by any competent paper hanger. Such murals may be obtained in any monotone, or may be colored in transparent oils.

Photo-murals offer an attractive yet relatively inexpensive method of producing unusual wall decorations for homes, offices, stores, and display rooms. One of the fascinating aspects of their application is the fact that the photograph or designs may be made directly applicable to the place in which they are hung. The sportsman may use murals of his various hobbies; office walls may reflect the spirit of the business conducted therein; industrial offices may be decorated with murals showing the exteriors and interiors of factories.

OUR POINT OF VIEW

Wildlife in Curricula

IN the United States it has long been possible for a student to find at many colleges and universities courses in almost any subject under the sun—almost, but not quite; game conservation and game management have been neglected by our institutions of learning. The hiatus has now been partly filled. Mr. Darling hints at this in his article on page 117 of this issue, when he mentions one arms manufacturer's contribution of 30,000 dollars a year toward this cause, but doesn't go into details for lack of space.

In a recent announcement from his office it was said that several state universities will now set up courses in game management. These are to have the active support of the Bureau of Biological Survey, which is prepared to supply instructors and to co-operate to the fullest. To the contribution mentioned above, the Bureau will add 42,000 dollars, and the universities and state game commissions will also share the expense. It is expected that the new courses will follow, in general, the lines of the forestry courses now found in many institutions; they will consider not only the teaching of modern game management methods but also original research work in wildlife subjects.

"This is the best thing so far as our non-migratory wildlife is concerned that has happened in years," Mr. Darling says. "It will mean the salvation of our upland game species. It means also that we shall at last be able to co-ordinate our research and experimental work." It will do away with the duplication of effort that has existed in the past when uncoördinated, scattered agencies often studied identical phases of wildlife subjects; and, further, provides the long-desired means, hitherto lacking, of disseminating the information that was gathered on these subjects.

"Ding," as Mr. Darling is better known to millions who have seen his widely used, dynamic cartoons, has devoted his efforts for years to the cause of American wildlife. He accepted his present position solely because of this one great interest of his; he felt that this would give him the opportunity to achieve the end for which he has so long fought. It is no mere coincidence, therefore, that an important stride forward has been made. Game will benefit, game commissions and conservationists will begin to see fulfillment of their dreams, and many thousands of people will profit by the work that Mr. Darling has so ably furthered. He is to be congratulated for his success so far. Let us hope he will be able, during his tenure of office, to expand greatly the number of institutions with courses on wildlife.

How Bright Is a Newspaper Columnist?

IN the July number of this magazine there was an article entitled, "How Bright is a Lightning Bug?", in which a professor of physics told how he measured the illumination of the common fire fly. He found it to be one fifteen-hundredth of a candle-power.

A columnist connected with an Oklahoma newspaper appears to have run across this article and half read it, and found the wheels of his imagination set spinning by an aspect of it which we confess that we, as the editors who included it in this magazine, have entirely missed. We have before us a clipping from that Oklahoma newspaper, in which the experiment is mentioned and commented upon as follows: "Imagine a guy going to all that trouble just to find out about that."

Ourselves lacking a sense of humor, we should rear up instantly in wrath to defend sacred science. But no. The poor overworked devil who wrote that line was probably hard put to it that day for something to comment about, in order to fulfill his daily stint of copy before his chief descended on his luckless neck—just as the present writer, a brother scribe, is at this moment racing against a printer's deadline and trying to forestall a similar fate. Had the same poor devil, however, had the energy in the sapping climate of Tulsa to read on, he would have found his answer in the very same article. "How the fire fly can radiate 'cold light,'" the article stated, "is a problem which has baffled science for many years, *and its solution will revolutionize our lighting industry.*"

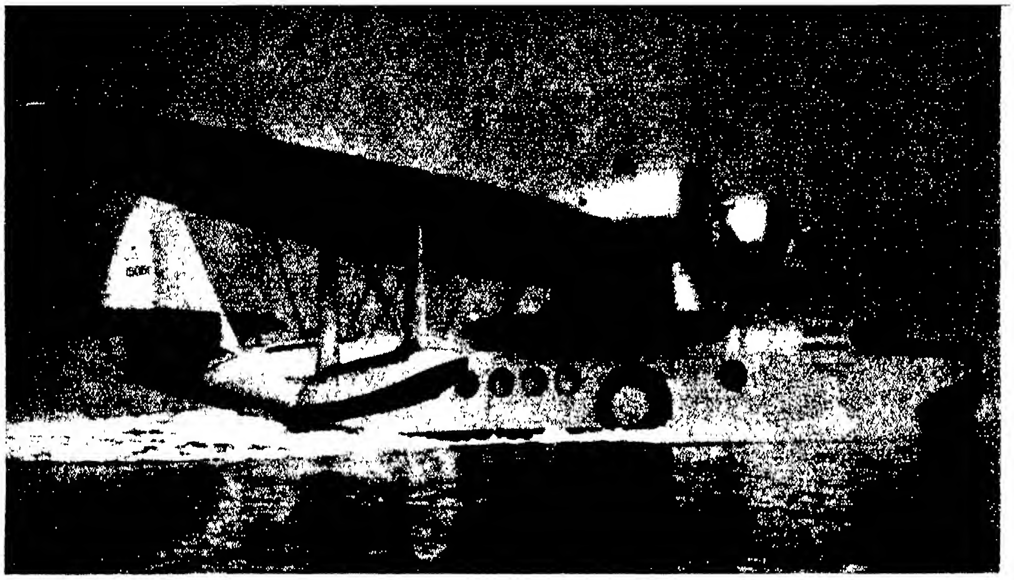
Perhaps science will not learn the solution of this economic advance by courting the fire fly's confidences; but again, perhaps it will. Anyway, scientists don't make fun of the fire fly; she does her best as a lamp and that means far better than man's own very best. Instead, they observe her as minutely as possible. Perhaps that was Professor Parlin's reason for measuring the fire fly's candle-power; or perhaps the same "guy" did it, in this instance, just because it was fun.

We can better agree with our facetious friend from Oklahoma in at least a part of another comment which he appends. He says, "That's what's the matter with this country. All our ignoramuses go to Congress and all our educated men run around with butterfly nets." Here he equals, or even surpasses, the full candle-power of one fire fly. But not all of our ignoramuses go to Congress.

Compe' .tion

OUR unbounded aith in the ability of American industries to take care of themselve in any fair competition makes our i: all the greater when goods from foreign sources are dumped upon our open markets with no distinction whatsoever as to their origin. A case in point is brought to light in a recent stipulation of the Federal Trade Commission wherein electric light bulbs were the bone of contention. According to the Commission's report, an American manufacturing concern was selling Christmas tree lighting outfits equipped with imported lamps, without marking the containers with appropriate words clearly stating the fact that the lamps were imported. This company used the same style of container, packings, and markings for sets equipped with American-made lamps as it did for other sets containing lamps marked "Made in Japan." These lamps were so marked, however, that the words indicating their origin could not be read after the lighting outfits were assembled for sale.

Since in this particular case an American manufacturing concern was a party to the petty deception, the warning to the American public is all the stronger. It has been definitely proved beyond a shadow of doubt that the large majority of American-made goods is far superior in quality to competitive goods imported from foreign sources. While we have no desire to wave the flag of biased, blind nationalism, it is our opinion that the American buyer will be protecting himself as well as American industries if he will purchase American-made goods of standard quality rather than allow himself to be misled into a "bargain" in shoddy goods of foreign manufacture. It is only ordinary horse sense to expect and demand the most for your money and usually *the most* can be obtained when you buy American-made goods.



Sikorsky *S-43*

WHY

transport aircraft for its exacting service, were correct. The further proof of this pudding has come of late in the Pacific arena where a sister ship, the Pan American *Clipper*, has been flying with the regularity of clockwork between the Pacific Coast and the territory of Hawaii, and between Hawaii and Midway Island, and those other dots in the wide ocean which mark the stations of the pioneer service from the United States to the Orient.

Upon the basis of the record-making performance of the first ship of this type, this great flying boat has erected an operating schedule, performed at a cruising speed which is almost exactly the speed which brought the records home. She has shown that record making is much more than a stunt, that it is the index of actual performance under service conditions, leading to new expansions in the realm of transportation by air.

Record Flights Point the Way to Scheduled Operation . . . Prove Correctness of Designs . . . Test Equipment . . . Provide an Index of Performance

By REGINALD M. CLEVELAND

IT was chronicled in the American press a few months ago, with no little jubilation, that the score in world aviation records, in the official categories recognized by the Federation Aeronautique Internationale stood as follows: France, 40; United States, 39; Italy, 21; Germany, 8; Poland 1; and Austria, 1.

This was a gain for the United States of eight new world's records, six of which were broken and two of which were set when Lieutenant-Commander D. W. (Tommy) Tomlinson set down the wheels of his heavily loaded Douglas transport at Floyd Bennett Field. With co-pilot Joseph Bartels and a third pilot—the inanimate but highly efficient Sperry gyropilot at the controls for 90 percent of the time—the former Navy "Sea Hawk" had smashed mark after mark for loaded land planes up to distances of 5000 kilometers in TWA's flying laboratory.

General satisfaction at this important accomplishment was justified, however, not alone because the United States had gained on the tally sheet as against France—which it may have surpassed by the time this article is in its readers' hands, by reason of attacks on altitude records with load by Tomlinson in the same ship, and others on amphibian speed records by the new Sikorsky *S-43*—but because such records as these reflect the true advancement of American design as exemplified in practical transport airplanes.

An air race across-country or around pylons can be one of the most thrilling spectacles that man has been privileged to watch. An effort to set a speed record over the official three kilometer course can hold one spellbound, even though the challenger of that record flies a straight line and alone. There is little thrill in making records by a long, closed-course grind of 1000 kilometers—621 miles—2000 kilometers—1243 miles—or 5000 kilometers—3105 miles, but these are the records that are of special value to everyday aviation, to the growingly important medium of air transport.

LAST Summer, with Colonel Charles A. Lindbergh, Chief Pilot Edwin C. Musick, and Sikorsky's famous test pilot, Captain Boris Sergievsky, in the cockpit, the Sikorsky *S-42*, later to be christened *Brazilian Clipper* by Pan American Airways, swung around a 311 mile course which ran from Stratford Lighthouse to Staten Island, Fire Island, Point Judith and return, to fly 2000 kilometers at an average speed of 157.5 miles an hour, and to add eight world's records for seaplanes with load to the two altitude records in this class which she had already made. It was a wonderful start on the campaign of regaining air records which, fostered by the National Aeronautic Association, is now so energetically being pressed.

But it was much more than this. It proved that the designs of Igor I. Sikorsky, the great airplane builder whose achievements were honored last June by the honorary degree of Master of Sciences from Yale University, and his staff, and the ideas of the technical committee of Pan American for efficient

COMMANDER TOMLINSON'S series of world and American marks for loaded land planes have a similar significance. When he sent the Cyclone-powered Douglas, carrying 2000 kilograms (4410 pounds) over the long triangle which ran from Floyd Bennett Field to Bolling Field to Willoughby Spit, near Norfolk, and back to New York, at speeds which averaged 190.906 miles an hour for 2000 kilometers, and reached 254 miles an hour between the Rapahannock and Hampton Roads on one lap, he was not merely performing a stunt. He was demonstrating in an unquestionable way that the Douglas was capable of carrying more than its normal payload for more than its normal non-stop range; both important factors of safety and performance for everyday airline operation.

These records showed even more. They were made with the airliner which is familiar on the routes of the "Lindbergh Line" across the continent, on many of those of American Airlines, and on the runs of Eastern Air linking New York and Chicago with New Orleans and Miami. This is a 14-passenger monoplane, powered with two 715-horsepower Wright Cyclones. Its successor nears the service stage. This will be a 30-place monoplane, also powered with two Wright Cyclones of a total horsepower only about 300 in ex-

SEEK AIR RECORDS?

cess of the twin engines now used. But, by the evidence of the wind tunnel, test flights, and the Tomlinson records, there is every indication that it will fly as fast and as efficiently, with its greater size and load, as its prototype.

At this writing, preparations are under way for an attack on a group of amphibian records by Mr. Sikorsky's latest creation, the *S-43*. This largest amphibian in the world showed its mettle beyond question the very first time it left the water.

With Captain Sergievsky at the controls, it started its take-off run on the waters of Long Island Sound off Stratford Lighthouse. Spectators on shore, watching through glasses, held their breath as they realized that the right engine was idling. But the plane surged up on the step, took the air, and climbed to 200 feet on the power of one engine: the first time a water-going aircraft has ever accomplished this feat from its natural element. Fuel pressure had failed on the right-hand line and it was not until a wobble pump restored the flow of gas that the second engine caught hold, and the rest of the first flight was made on full power.

THIS 16-passenger, clean-cut monoplane amphibian unquestionably has a top speed of around 200 miles an hour, and will cruise around 180 for 750 miles non-stop with full load. The records that are sure to fall in its lap will not mean merely another feather in America's cap. They will indicate that an aircraft has been put into service which may well change in important respects the whole airline map of the United States and its possessions, because an amphibian with performance equal to fast land planes of the modern type will be available.

Translated into scheduled operation, this may easily mean the development in key cities of the United States of seaplane landing facilities like the new Thirty-first Street ramp in the East River, New York City, which has demonstrated its ability to handle water-going planes ranging from a little Fleet up to a Martin bomber on floats. With these facilities it would be altogether possible to operate from the heart of one city to the heart of another without the lag now entailed by the trip from center to airport by ground transportation.

The saving which this would bring about in point of time can be realized by the example of service between New York and Chicago. Between these major cities the time in the air, averaged in both directions, is now a little less than five hours, but the time from hotel to hotel is very close to seven hours, and involves a change of vehicles and of baggage.

ONE takes a taxi from his hotel or place of business to the airline's city terminal, then a bus or limousine to the airport, and this process is reversed upon arrival. If, however, the East River ramp and one like it on the Chicago lake front were used, one 15-minute taxicab ride should suffice at each end and, roughly, an hour and a half would be knocked off a seven hour journey.

There is little question that good results for American aviation could come out of efforts to regain certain absolute records — without load requirements, now held abroad — notably the altitude record of 47,352 feet by Commander Renato Donati, now held by Italy, and the world's speed record of 440.681 miles an hour, made by Francesco Agello and also to Italy's credit. From the first might easily come valuable lessons, especially in regard to engine supercharging applicable to military operation, as well as to the substratosphere flying which is peeking around the corner.

The absolute speed record is an expensive achievement. The Schneider Cup Races cost England each year that she competed about $1,000,000, but from them unquestionably stemmed some of the more efficient of the Rolls Royce military aircraft engines and the Hawker Fury and Super-Fury, neither showing quite the performance claimed by enthusiastic Anglophiles, but both among the swiftest combat airplanes.

There is reason to believe that the world's land plane speed record, held by Raymond Delmotte of France at 314.319 miles an hour, may fall to America this year. Here is another prize worth gunning for, not alone from the sporting angle, but because of its implications in plane and engine design.

But whatever the value of the records which do not involve carrying a load, there can be no question that those involving speed and altitude with load have an importance for practical air transport which transcends the satisfaction involved in their winning.

A Douglas airliner over the Continental Divide

Photographed for TWA by Margaret Bourke-White

IN DEFENSE OF INSECTS

Only 300 Species Out of 500,000 Are Man's Enemies . . . No Insects—No Silk Stockings, No Fruit . . . Even the Hated Housefly Now Useful

By ALBERT DICKMAN, Ph.D.

If you were given the power of a genii to destroy forever all the insects, entirely ridding the world of them—likewise all the bacteria—would you give the command? Few of the bacteria, relatively speaking, do us any harm and the same is true of the insects. Most of them are either harmless or actually helpful to us.

Will the next age of the world be the Age of Insects? Alarmists urge the danger of insect domination. Suppose, however, we look at the same question from the insects' point of view. Here is an animal that was on earth millions of years before man's most remote ancestors appeared. It is the insects, rather, which have cause to worry about the end of the Age of Insects and the beginning of the Age of Man. "Scare-you-all" articles which envision man's defeat by the insects are perhaps a bit sensational.—*The Editor.*

ACCORDING to some of our foremost entomologists, man is fighting a losing battle with insects for supremacy of the world. We are besieged on many fronts. Our crops are devoured, our homes undermined, our health and our very lives are placed in jeopardy. The cost of insect destruction to food crops, in North Dakota alone, amounted to the sum of 10,000,000 dollars in 1933, while chinch bugs in the same year caused an estimated damage in Iowa of at least 25,000,000 dollars. Termites by their destruction of wooden structures cost American home owners more than 30,000,000 dollars a year.

The yearly losses caused by the destruction of food crops in the United States is greater than the cost of our entire educational system, and nearly twice the cost of the maintenance of our army and navy.

Moths and beetles attack our clothing, furniture, and stored foods. Maggots of bot flies develop in the bodies of our living domestic animals, causing fatal diseases in some, and perforating the hides of others. Mosquitoes were responsible for 100,000 deaths in the United States—deaths from yellow fever alone—from 1793 to 1900; they alone are responsible for the transmission of malaria. Houseflies may be responsible for the transmission of typhoid fever, dysentery, cholera, and tuberculosis; lice transmit typhus and relapsing fever; tsetse flies transmit African sleeping sickness, and according to recent reports the caddis fly with its 2000 or more shedding hairlike scales is responsible for numerous cases of asthma.

From the above it might be hastily concluded that insects are the earth's deadliest wild animals, and that a relentless battle should be fought for their complete extermination.

This denunciation of insects, fortunately, cannot be extended indefinitely, for to our astonishment we soon realize that our list is disappointingly short and that, after investigation, man's convicted enemies in the insect world amount to only about 300 species. When

Courtesy Journal of Bone and Joint Surgery

How maggots are applied to an infection of the skull, where they soon clean up the dead tissue

we realize, too, that at the present time over 500,000 species of insects have been classified, and that thousands of unclassified specimens are accumulating in museums, universities, and in the pockets of entomologists, we find we cannot justly condemn a whole class because of an extremely small number of disreputable members. Suppose insects do destroy 10 percent of our crops? What of it? What a small fee they exact, when we consider that without the aid of insect pollination we would have practically no crops at all!

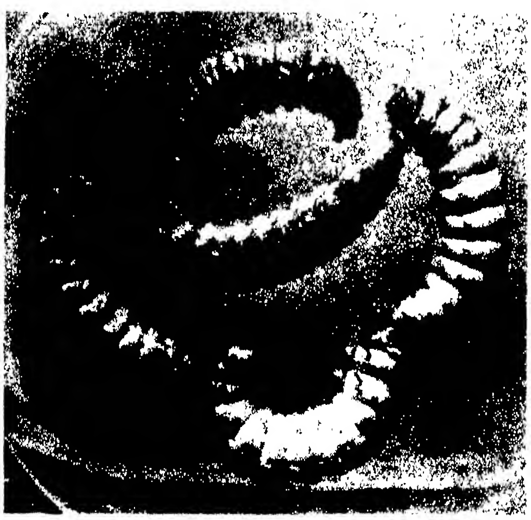
COMPARED with the 500,000 species of insects we find that there are only 30,000 known species of vertebrates. But in this last group we find all of the animals with which we are most familiar; those usually represented in zoos and aquaria, all of the birds, the reptiles, the fishes, the frogs and toads, the hair and fur-bearing animals. Among these, one species of snake, the cobra, kills about 20,000 natives in India yearly. According to our own government reports, wolves, coyotes, mountain lions, and other predacious animals in one year destroy over 20,000,000 dollars of our wealth. From incomplete statistics we are told by a reliable authority that, in Germany, rats alone destroy 50,000,000 dollars worth of property, while in England they destroy 400,000,000 dollars worth. Another authority states that the annual economic loss due to the destruction by rats in the United States is higher than one dollar per rodent. On one cane plantation in Puerto Rico where there were less than five hundred people, 25,000 rats were killed in six months!

Plague, better known to us as the black death, and primarily a disease of rats, at one time erased 50 percent of the

total population of the Roman Empire, and during the 14th Century in Europe killed about 25,000,000 people.

Insects, the little creatures, are not so bad. It is very likely that man, in the future as in the past, will continue to keep in abeyance those of them which are injurious to his health and well-being, and at the same time divert the activities of others to the common good.

How many times will the value of our silk commodities offset the destruction of the Japanese beetle? We are too prone to forget the beneficial aspects of insects, and the millions of dollars of wealth produced in the form of fruits, silk, honey, beeswax, dyes, and lac by them.



Below: Larvae of the waxmoth. _Above:_ Destruction to waxcomb by larvae of the waxmoth, or beemoth. The moths lay their eggs in the hive; these hatch and eat

Locusts, which lay waste great areas, are not only in many cases welcomed by natives as delicious items of food, but by their destruction they clear the lands of useless perennials and grasses and encourage the growth of new grasses and young plants, thereby affording future food supplies for wild cattle and game.

WE must be thankful to the insects for the destruction of dead and decaying animal and plant bodies which otherwise would in a short time litter the face of the earth. It has been stated that three flies, due to their rapid multiplication and activity, will devour a dead horse as quickly as would a lion, and were it not for the activity of drilling insects, a century would elapse before the elements alone would remove from the face of the earth the ruins of one of the hardwood tropical trees.

Numerous species of insects have been used since biblical times as a source of dyes. One particular species was used for dying cloth blood-red or crimson. The crimson dye of the Greeks and Romans, and the imperishable reds of the Brussels and other Flemish tapestries, were produced from the bodies of these insects. It was universally used before the discovery of the New World and the introduction of cochineal from America by the Spaniards.

The dried bodies of the female cochineal insects were being used by the native Mexicans when the Spaniards under Cortez arrived in Mexico in 1518. Although supplanted to a great extent by the cheaper but inferior coal-tar colors, cochineal is still produced commercially in many parts of the world. Before the use of the cheaper substitutes, 800,000 pounds of cochineal, valued at 9,600,000 dollars, was annually imported into Europe.

Thank the insects for lac, which is the excretion of a certain minute species. Twenty-five thousand tons, valued at a million and a quarter dollars, are produced annually in the central provinces of India. From it we obtain our finest grades of sealing wax, and shellac which is the chief ingredient of most wood polishes and of the coating on the fine lacquer ware used so much in China and India.

For evidence of the insect's martyrdom to man's progress in medical sciences, visit any one of our institutions erected and endowed for the study of cancer, and you will see numerous species of insects among such unusual experimental organisms as salamanders, crayfishes, and onions. Cancer is primarily a problem of cell growth and cell multiplication. Tear off a few legs from an insect, explain the sudden rapid growth of tissues and multiplication of cells to regenerate these lost parts, and you have fundamental information with which to help explain similar spontaneous growth of cells in the cancers of human beings.

The females of insects commonly grouped as gall insects, deposit their eggs in the tissues and stems of plants. The adults, having performed their primary function in life, perish, and the young begin their solitary struggle for survival in the stems of the plants. But there is a dearth of food in the small stems. The insect larvae in some remarkable manner stimulate the plant cells which surround them to multiply prolifically, and thereby furnish an abundant and constant supply of food material. What is this stimulus? How will the discovery of this mechanism ultimately affect our procedures in cancer research?

APINIZATION is one of the newer treatments for rheumatism. A long series of cases recently reported by two French physicians gives evidence of the efficacy of this treatment. The equipment is astonishingly simple, inexpensive, and occupies little space. It is merely a number of living, freshly caught worker honey-bees and a pair of tweezers. The treatment consists, essentially, of holding the bee by means of the tweezers against the ailing spot. The bee does the rest. Since the bee poison which displays these beneficial properties also manifests the properties of cobra venom and such alkaloids as strychnine and belladonna, treatment must be carried out under the observation of a qualified physician. In a number of stubborn cases which could not be relieved by conventional treatments, remarkable results followed a series of stingings. To remove the risk of infection from the stings, sterile extracts of the bee poison were made, with the added advantage that bee poison was made available at all times of the year.

In addition to the yearly production of millions of dollars worth of honey and wax, you may now credit the honey bee with having relieved human suffering—and it is very possible that in the near future they will take places in our laboratories beside horses, calves, and guinea pigs, as sources of materials in our fight against disease.

During the World War a keen and imaginative American surgeon was stationed at a base hospital in France. Ambulances returned periodically from the battlefields with wounded, frequent-

Photo by the Philadelphia Commercial Museum

Honey bees have been experimented with in the treatment of "rheumatism," but this is not a general recommendation that rheumatics try the treatment

ly with men who after a few hours on the battlefield possessed seriously contaminated wounds and general systemic infections. In such cases the mortality rate was extremely high. On a number of occasions, when the barrage was exceptionally severe and when the shelling and machine-gun fire continued uninterrupted, it was impossible to recover the wounded for periods of several days. On such occasions it was noticed by this surgeon that certain soldiers who had lain upon the battlefields for as long as seven days without food, water, or medical care, and suffering from severe wounds, showed upon examination no fever or general infection. Upon carefully removing the tattered clothing from the wounds he was astonished to see them infested with numerous squirming fly maggots, and the tissues around the wound in a miraculously healthy and healing condition. The minute fragments of bone and dead tissue had been entirely removed by the maggots, and the usual pus condition was missing.

SOME years after his return to the United States, and with these observations in his mind, he began experimentation upon laboratory animals, using clean, living maggots in the treatment of infected wounds. His results were so uniformly successful that he began their use in the treatment of similar human ailments. As a monument to his keen observation you can find on hand in numerous hospitals a supply of sterile maggots; or if you are interested you may obtain the name and address of a source which supplies them on a moment's notice, for the treatment of certain bone infections and similar diseases.

Very recently two physicians experimenting with the use of maggots in the treatment of diseases, and realizing that the maggots not only neatly remove the dead tissue of a wound but also produce some substance which prevents the growth of harmful bacteria in wounds, ground up maggots, producing an extract which, upon injection into individuals suffering from these bone diseases, has produced remarkable results. With internal infections, such as sinus and mastoid infections, where whole living maggots cannot be employed, injection of this extract is producing interesting results. Who will estimate the value of these insects in the short time of their use, in the alleviation of human suffering and the preservation of life?

Have you ever heard of the beemoth? From the time of Aristotle it has been denounced as a serious pest. It is the brazen little rascal which will creep into a beehive at night and whose offspring will in a very short time reduce the hive to a mass of debris. It is warred upon by beekeepers in all the civilized countries of the world. But visit a number of scientific institutions and you will find this pest carefully protected and fed, and kept comfortably warm in special incubators.

In a celebrated French institution of medical research this insect has offered very convincing evidence in favor of a long ridiculed biological belief. At present it is generally accepted that acquired characteristics are not passed on by parents to the next generation. But these little insects, after being injected for a successive number of generations with certain germs, have been shown to acquire an immunity for those germs, which they are then able to pass on to future generations.

Man's defense against the attacks of invading bacteria consists, among other things, of the destruction of these germs by the white corpuscles of the blood and of the production of chemical substances which disable and destroy these minute enemies. In the case of numerous diseases, however, the body may be entirely overcome by the rapidly multiplying invading hosts before the white corpuscles can rally to the attack and before the chemical factories of the body can be set in operation on an efficient and effective basis.

If the body, in such circumstances, can be immediately fortified by the injection of the ready-made chemical substances or antibodies into the blood stream, the invading bacteria may be destroyed or at least held in check until the patient is able to get his own factories in operation.

WHERE are these chemical bullets obtained in such emergencies? They are of such complex chemical nature that none of them can be made in our chemical laboratories. And each germ is vulnerable to its own particular bullet. In a number of cases, laboratory animals such as horses, rabbits, and guinea pigs are transformed into living factories for the production of these protective substances on a commercial basis. When certain germs are administered in proper and safe form, the animals begin the production of these antibodies which accumulate in the blood.

Attempts up to the present time to produce a serum for the treatment of tuberculosis, one of the greatest scourges of the human race, have been unsuccessful. No living factory has been found capable of becoming immunized and an effective producer of antibodies for this deadly germ. But there is a little creature which for many years has kept from man the secret of its own superiority over man, in the display of a complete immunity towards the tubercle bacillus—that same waxmoth or beemoth, the little pest of beekeepers, is immune to the tuberculosis organism! Inject into one of these insects enough tubercle bacilli to kill a whole laboratory of guinea pigs and the germs are immediately destroyed in its body. In the body of the waxmoth is a substance which stimulates the prompt and complete destruction of the tubercle bacillus, a substance rare or absent in human beings.

There are some few insects which, to be sure, are among our enemies. But let us hope that no one discovers a means of eradicating all insects overnight.

TEMPERED GLASS

Resists Temperature Changes . . . Can Be Twisted or Bent . . . Stronger Than Ordinary Glass . . . Clear or Colored

SPRINGBOARDS and swing seats made of plate glass serve to illustrate dramatically certain qualities of tempered glass, but only hint at the industrial applications that are sure to follow the introduction of this product to the American market. Tempered glass has five distinct advantages over ordinary glass: It is approximately five times stronger; will bend far beyond the breaking point of other glass; can be twisted to a remarkable degree; is impervious to sudden changes in extreme temperatures; and if broken under severe strain it crumbles into innumerable pieces without sharp edges.

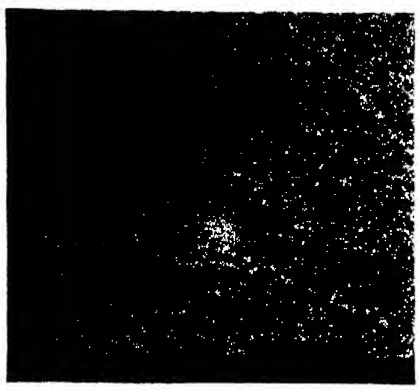
Briefly, tempered glass is produced in a manner similar to the "tough glass" described on page 330 of our June 1935 number, made for optical purposes. Ordinary plate glass is heated until it is almost plastic and then is suddenly air cooled. Thus strains are created, developing high compression on the outer surface of the glass, while the interior is under tension or pressure.

Tempered glass can be provided only on special order, since after it has been made it cannot be cut to size. When the surface is penetrated sufficiently deep with a cutting tool, it will crumble immediately. It has not yet reached the stage of development where it can seriously be considered as a safety glass for motor cars.

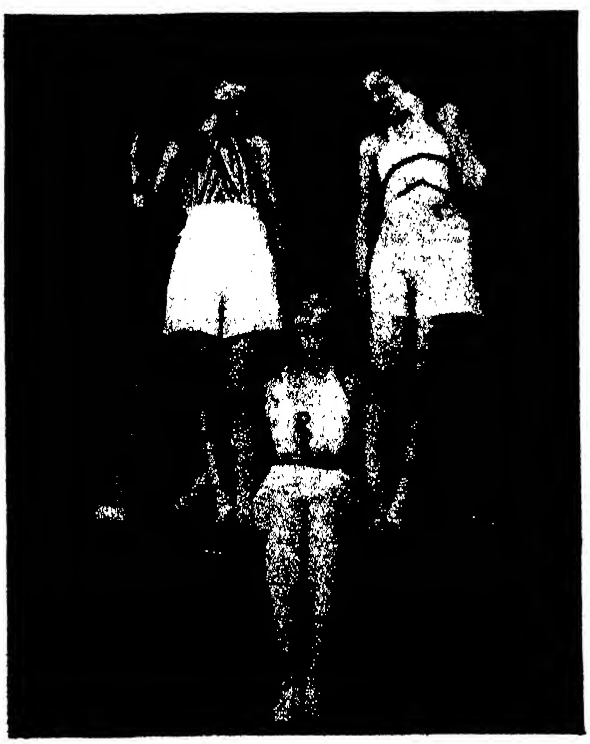
Possible applications of the glass, which may be either clear or colored, are: Port holes in furnaces; guards for thermal instruments; shelving carrying heavy loads; windows in deep-sea diving bells; illuminated signs; and in many other uses where transparency is desired but where the short-comings of ordinary glass rule it out.

A sheet of the new tempered glass served as a diving board in a recent test. The young lady's weight has bent the strip far beyond the breaking point of ordinary glass

Courtesy Libbey-Owens-Ford Glass Company



Above: **A heavy weight was dropped on this pane of tempered glass. Instead of shattering into long slivers with jagged edges, as would ordinary glass, it crumbled into tiny fragments with blunt edges**



Left: **Three girls on a swing seat of glass, yet under their combined weight the seat only bends; it is tempered glass**

Right: **When hot water is poured on cold glass—look out! But when molten lead is poured on a sheet of tempered glass that has been cooling off on ice—nothing happens**

TUMBLING CAISSONS

Caissons Constructed Upside Down on Ways . . . Launched . . . Built Up . . . Turned Over . . . Sunk in Clay . . . Workmen Inside Excavate Water Bed

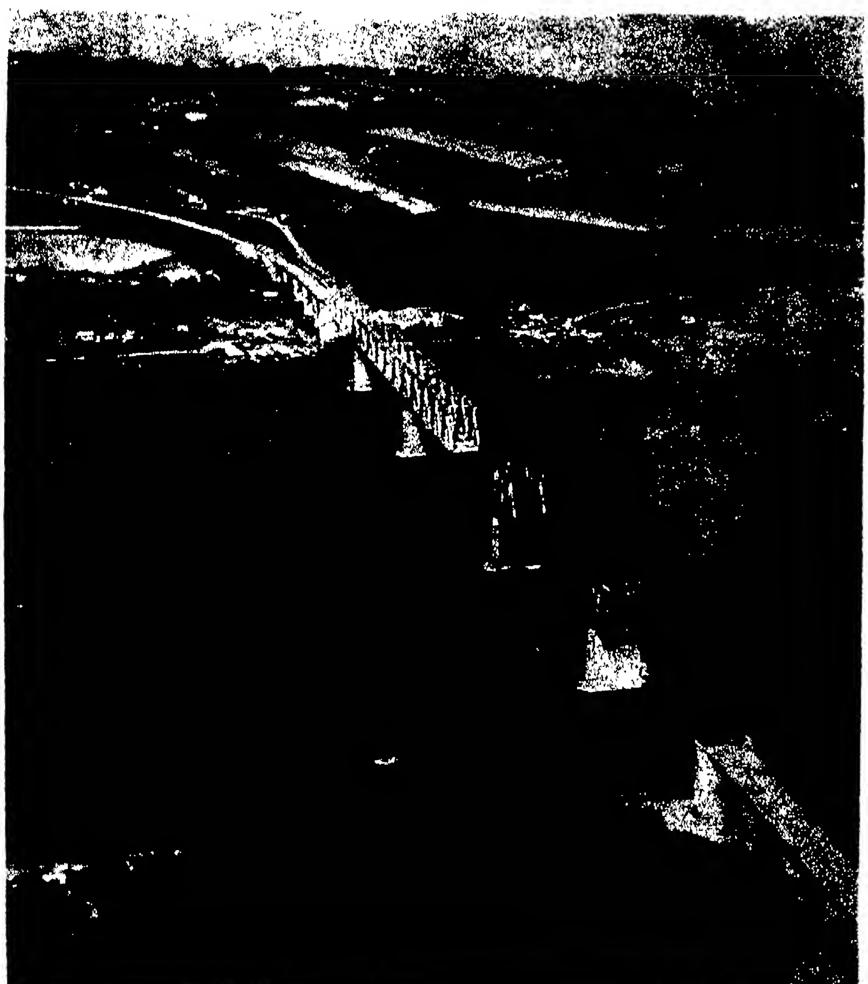
By R. G. SKERRETT

THE Danish State Railways system has recently completed and opened to traffic a combined highway and railway bridge that spans what is known as the Little Belt a deep and rapidly flowing link with the sea that separates the peninsula of Jutland from the large Island of Fünen. The building of this up-to-date steel structure called for the mastering of a number of physical problems, which the responsible engineers accomplished in unusual ways.

The Little Belt Bridge is a concession to the modern demand for speed in transportation, dispensing with a ferry service that has been continuously active since 1872. The vessels that have been employed on the run in latter years are of ample size to carry on each trip about 30 freight cars and passenger coaches. With favorable weather the ferries have made the run in about 15 minutes; but fog, snow, and ice at times have seriously upset train schedules and caused delays.

The crossing of the Little Belt is a link in the much used railway route between Esbjerg on the North Sea coast and Copenhagen, the capital city; and the Little Belt is threaded by a very considerable volume of international water traffic. It was, therefore, necessary that the over-water sections of the bridge should be held high enough to afford clearance under all tidal conditions to the tallest masts of vessels navigating the Little Belt; it was equally vital that the several piers supporting the steelwork should be securely anchored in the bed of the stream where the channel is deep and the currents strong and swift.

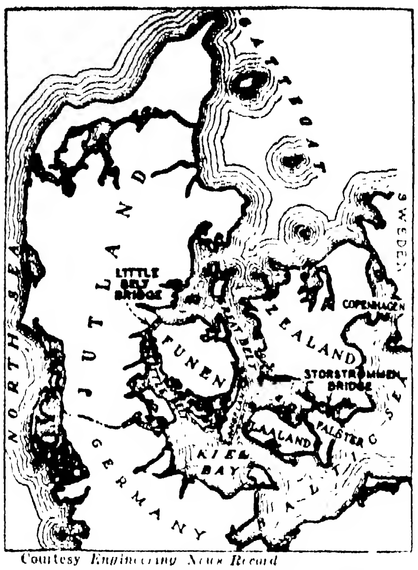
With the single exception of the dominating peninsula of Jutland, which is part of the mainland of western Europe, Denmark is otherwise an aggregation of islands, great and small, that number approximately 500. A glance at any large-scale map of the kingdom will reveal how often waterways have to be spanned either by bridges or ferries in maintaining train services between the outstanding cities of this industrious and picturesque nation.



An arm of steel on high piers reaches across the Little Belt, a 2700-foot water gap between the Peninsula of Jutland and the Island of Fünen, Denmark

THE Danish Parliament authorized the bridging of the Little Belt in 1927. Construction was started the year following, the work being entrusted to an associated group of four experienced engineering and construction firms. The plans called for a water crossing made up of five steel spans, having a combined length of 2706.68 feet, and on each shore an arched concrete approach of exceptionally graceful lines—the entire structure to be a trifle more than 3864 feet long. The central span, which bridges the main channel of the Little Belt, is 721.78 feet long between the centers of the two supporting piers, and the underlying waterway has a maximum depth of something more than 131 feet at mean low water. The water bed at three of the four offshore pier sites lies between 101.7 feet and 99.4 feet below the surface of the stream, and the tidal sweep attains a velocity in excess of seven miles an hour.

These two circumstances made it clear that great care would have to be exercised in locating and sinking deeply the caissons forming the foundations for the piers for the steel spans. The first problem was how best to do the work: the second, that of keeping the cost as low as possible while still assuring rigidity and strength. Success, in any case would be contingent upon knowl-



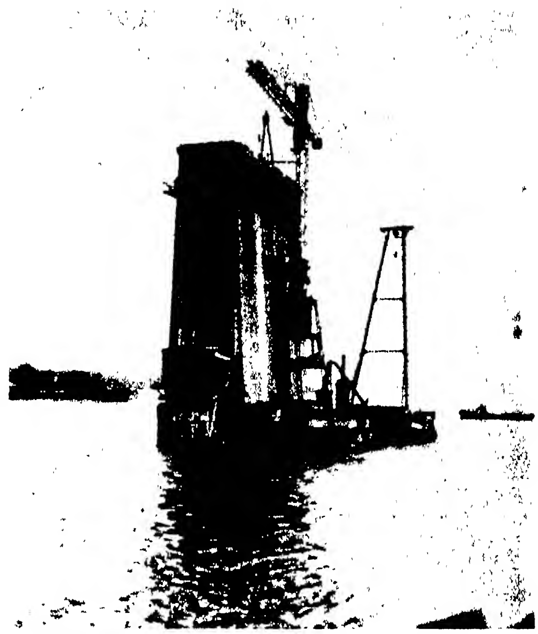
Courtesy *Engineering News Record*
Location of Little Belt and another bridge being built in Denmark

edge of the water bed into which the caissons would have to sink. Exploratory drilling indicated that the underlying formation is mainly composed, to a depth of hundreds of feet, of clay that is so compact that it is impervious to water when penetrated less than 15 feet below the channel bed. The surface of the water bed, however, is extremely uneven; and that fact influenced the modeling of the caisson for each pier site.

The depth of the water in which some of the piers would have to be set, and the added depth to which the caissons would have to be sunk into the channel bed, precluded the employment of sand hogs and the use of caissons having working chambers of the conventional types—those filled with compressed air to hold the outlying water at bay while excavating the earth underlying the caissons. The Danish engineers developed caissons that could be sunk into the clay bed by dredging operations carried on by workmen in a working chamber in the caisson and on the surface of the Little Belt. The cutting edge of one of the caissons rests at a depth of 132 feet below the surface of the stream, and the surmounting pier rises virtually 105 feet above the water.

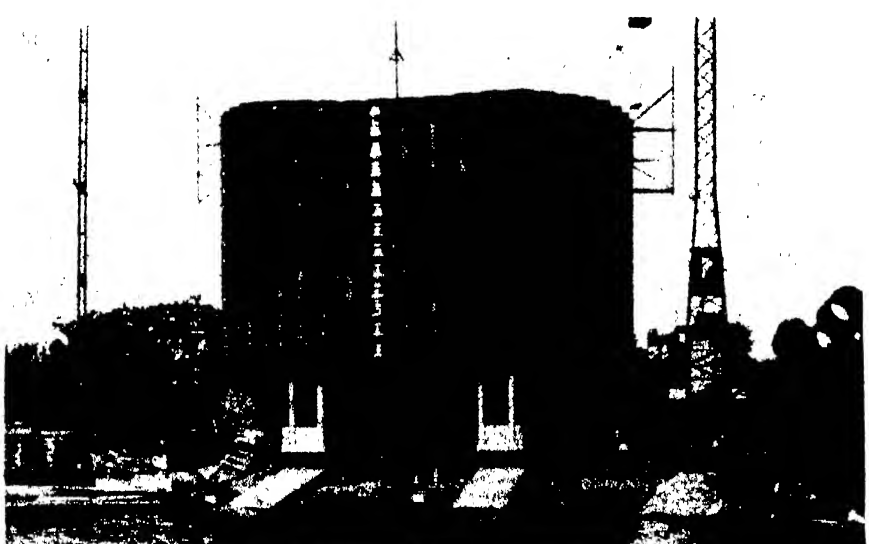
Because the cutting edge of each caisson was modeled to conform to the surface of the water bed, and was therefore irregular, the caissons were constructed upside down on shore, the flat deck above the ceiling of the working chamber resting on the building blocks from which each caisson was successively launched when ready. After being floated, the caisson was ingeniously made to turn turtle so that the flat bottom would become the top of the structure on which to erect progressively the concrete and the masonry superposed sections of the bridge pier. Each caisson at the time of launching had a dead weight of fully 7000 tons. To cause it to turn over and to control that motion at the proper time entailed the making of exact calculations and the exercise of nice regulation of so great a mass.

Viewed from above while building, the two parallel sides and the two semicircular ends of each caisson were composed of a continuous line of reinforced-concrete tubes, 76 in number, with a uniform internal diameter of nearly four feet. Immediately within the strange looking structure and strengthening the outer wall of the interconnected vertical tubes, were 22 similar tubes arranged symmetrically. All these tubes were later used to excavate the clay underlying them when a caisson was landed on the water bed at its given location. Thus, as the excavating proceeded, uniform sinking of the caisson was affected and the structure kept upright.



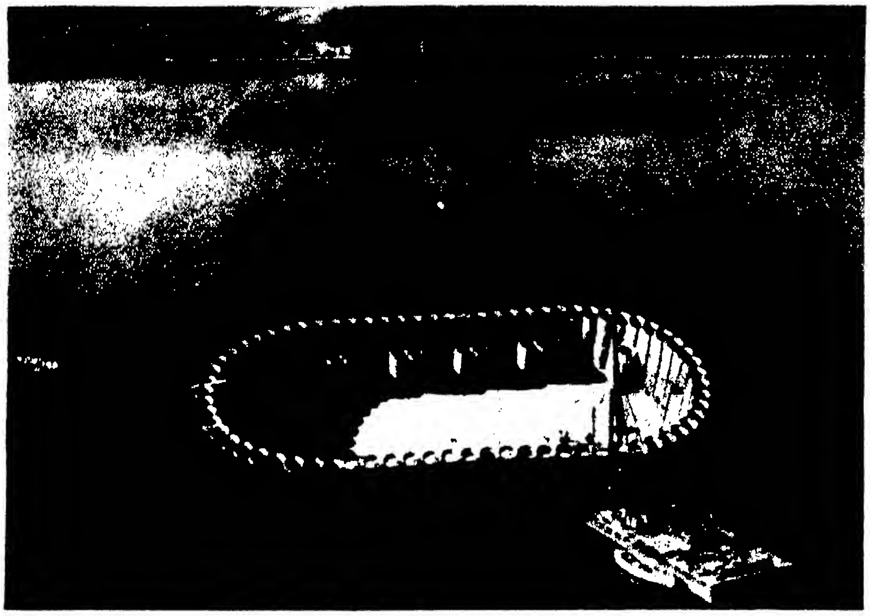
One of the four sturdy piers of the new bridge which rise to a height of 105 feet above water

The enveloping tubes were joined to the massive concrete ceiling of the working chamber and also to the reinforced concrete walls supporting a second deck—the latter forming the bottom of the caisson while on the building blocks. The interior between the working chamber ceiling and the succeeding deck was divided into a number of separate compartments by lengthwise and crosswise heavy walls of concrete. These subdivisions were used to hold water ballast for upsetting a caisson, and to regulate its stability and dead weight while it was being towed to the pier site and landed on the bottom of the Little Belt. Admission and expulsion of the water ballast could be regulated as occasion required. At the time of launching, the highest point of the tubular walls of some of these caissons was as much as 60 feet above the under-most part of the structure. The uniform length was about 146 feet, and the maximum width was 75 feet—a large and heavy body to launch and then to control during the subsequent operation of capsizing.



On the ways, completed and ready for launching: A caisson built upside down, the ceiling of the working chamber within being at the bottom of the structure

THE method employed in turning a caisson through an arc of half a circle was both ingenious and simple. Several hundred tons of water ballast were admitted to one of the side compartments. The further necessary tipping weight was in the form of sand poured into the upturned openings of several of the perpendicular tubes on the same side of the structure. The admission of a little more water ballast was all that



A caisson, first towed into deep water, being made ready for the job of overturning. After it is capsized, the rims of the cellular walls became cutting edges

was necessary to heel the caisson over until water could pour into the great central cavity over the depressed lip of the cutting edge. As soon as the former bottom of the caisson swung up to the surface, all the sand ballast automatically dropped out of the downturned tubes. The caisson was then brought to a level by allowing the water ballast to flow partly into a neighboring chamber, on the opposite side, and thus bring about a balanced distribution. The caisson was then towed to a point where the water was of suitable depth, and anchored where a floating concrete plant furnished the material for adding to the upper part of the caisson. This operation was continued two more times, the caisson being shifted successively to deeper water, and then moved to its final position at the given pier site. By that time, the superstructure was high enough to be above the surface of the Little Belt at high tide, with the cutting edge resting on the water bed at all points.

THE bottom material under the approximately elliptical cutting edge was next removed, step by step, by means of a novel boring and excavating tool which was lowered into each of the wall tubes to cut away and remove the clay encountered at the open lower end of each of these wall units. The boring tool was made up of a large cylinder of steel with its lower edge formed into a series of saw-like teeth. Within the cylinder, near the bottom, were radial arms, also toothed, that broke up the bottom material. Powerful jets of water promoted further disintegration, and a continuous discharge of high-pressure air formed an emulsion and helped to lift the excavated material to the surface. The rotating shaft of the drill was hollow to provide a passageway for the upward flow. In this manner, the cutting edge was worked deeper into the compacted clay of the water bed, and at the same time the unexcavated area of the water bed rose correspondingly higher into the working chamber of the caisson. This material had next to be removed to permit the caisson to settle to its designated depth.

Because of the favoring firmness of the clay, no water could enter the working chamber from beneath the caisson when the cutting edge was something like 12 feet below the surface of the bed of the channel, and workmen could descend into the chamber through certain of the inner tubes that had their lower ends some distance above the cutting edge. These men worked under atmospheric pressure and "in the dry," as it is termed, and loaded buckets that were hoisted to the surface and dumped overboard. In this manner, the bottom material projecting into the working chamber was gradually removed and leveled to the desired depth so that the ceiling of the working chamber could come to rest there when the caisson had settled to the proper depth in the clay bed.

With all four caissons in place and their surmounting piers of concrete and masonry carried to their crests, 105 feet above the water, the steel workers started the erection and gradual extension of the five cantilever spans that reach from shore to shore of the Little Belt and link the peninsula of Jutland on the west with the Island of Fünen on the east.

THE bridge, which has a width of nearly 60 feet, carries two railway tracks, a vehicular roadway wide enough for two lines of traffic and a sidewalk about eight feet broad. The reinforced-concrete approaches have been skilfully designed to harmonize with the weblike steel spans, and the longest of the arches has a spread of nearly 150 feet, which is notable.

The building of the Little Belt Bridge has aroused much interest in European engineering circles because of the resourceful way in which all difficulties have been mastered. The Danish people and the many thousands of visitors annually from abroad will benefit by the year-'round time-saving now assured them by this bridge.

The caissons and piers for the Little Belt Bridge were designed and built by Messrs. Monberg and Thorsen, of Copenhagen and the Grün and Bilfinger Company, of Mannheim, Germany; while the steel for the bridge and the erection of the spans were covered by contracts with Friedrich Krupp A.-G. and the firm of Louis Eilers, both of Germany.

The splash made by a caisson in turning over through a half circle. This delicate job entailed careful calculation and the use of water and sand ballast

The Cosmic Ray Puzzle

Once Believed to Be Light of Extremely High Frequency, Cosmic Rays Are Now Thought to be Mainly, or Largely, Charged Particles . . . But the Final Answer Still Remains a Mystery

By JEAN HARRINGTON

THE long dispute over the nature of cosmic rays is perhaps at last coming to a conclusion. The study of this penetrating radiation from outer space has for years been a battlefield on which two opposing schools of thought struggled for supremacy. Dr. Robert A. Millikan of the California Institute of Technology is the leader of the older school, which maintained that the rays were made up of photons or light quanta. The exponents of the newer theory, led by Dr. Arthur Holly Compton of the University of Chicago, are diametrically opposed to this view. They believe that the rays are streams of electrically charged particles, including positive and negative electrons, with possibly some protons and alpha particles.

During the 1920's, when quantitative evidence was still scarce, the opposing forces were too nearly equal to concede victory to either theory. Within the last few years, however, a flood of new data has indicated that at least a large part of the cosmic radiation consists of charged particles. One by one the supporters of the photon theory have deserted the ranks to join Dr. Compton and his particle theory. Dr. Millikan was left to defend the photon practically singlehanded. Now it appears that he, too, is partly changing his mind.

BOTH scientists are Nobel prize winners, and stand today in the foremost ranks of atomic physicists. Their vigorous disagreement over cosmic rays has made the study of the phenomenon one of the most dramatic developments of modern science.

The radiation was discovered early in the century and, because of its extreme penetrating power, it was at first identified with the gamma rays which emanate from radioactive elements. In 1910, however, the Swiss scientist Gockel and the Austrian, Hess, carried instruments far above the earth in several balloon flights, and discovered that the intensity of the rays increased with altitude. They could not, therefore, come from any elements on the earth, but must originate far outside the atmosphere.

Cosmic rays are distinguished from the many other kinds of radiation known today by their extremely high energy. They can penetrate a sheet of lead with as little blocking effect as a ray of sunlight encounters in coming through a window pane. Regener, sinking a sensitive electrometer in the waters of a mountain lake, detected their presence at a depth of 700 feet. The lake was presumably free from radioactive contamination, and no other known rays could possibly have traversed such a thickness of water.

Since at that time, particles of such great penetrating power were unknown, scientists naturally assumed that cosmic radiation must be of the same nature as light. The energy of light depends directly upon its frequency or rate of vibration. In order to account for the tremendous energies of the cosmic rays, it was necessary to associate an extremely high frequency with them. The higher the frequency of an oscillating motion, the shorter its wavelength; but in the case of cosmic rays the theoretical wavelength was far too short to be measured by even the most sensitive experimental means. Thus there could be no direct test of the soundness of the photon theory.

Nevertheless, scientists accepted it for many years as a matter of course. It was not until the late 1920's, when new evidence was brought forth, that any serious doubts arose to threaten the old ideas. In 1927 the Dutch physicist, Professor Clay, discovered that the intensity of cosmic rays was less in some parts of the world than in others. His finding stimulated a number of similar investigations. In 1932 and 1933, Dr. Compton undertook a series of very careful and widespread measurements. Observations were taken at 81 stations all over the world, and the records confirmed quantitatively the results which had been obtained by Dr. Clay. They showed clearly that the intensity of the radiation increased steadily from the equator to the poles. Dr. Compton explained this effect by the hypothesis that the rays were made up of small, electrically charged "bullets," shooting through space with tremendous velocities.

When any electrical charge is in motion, it creates about itself a magnetic field. If it happens to pass through another magnetic field, the interaction of the two fields tends to deflect the charged particle from its straight-line course. An electrically neutral particle, such as a photon, undergoes no such deflection. Now the earth itself acts as a great spherical magnet, with its north and south magnetic poles near the geographic poles. If the cosmic rays do consist of charged particles, those encountering the earth's magnetic field would tend to be driven away from the equator and toward the poles. Only the particles of extremely high velocity would be able to pass through the field and reach the region of the equator without appreciable deflection. The fact that more cosmic rays actually do reach the surface of the earth in higher latitudes than in equatorial regions is a powerful weapon to combat the photon theory.

DR. MILLIKAN, skeptical of the results of others, undertook a world-wide expedition of his own. He confirmed Compton's measurements of the variation of intensity with latitude and, unfortunately for his own theory, uncovered another bit of evidence in favor of cosmic ray particles. This is the variation of intensify with longitude. The earth's magnetic field is not symmetrical with respect to its axis of rotation, but is slightly off center. The strength of the field is therefore not constant all around a given parallel of latitude. Since the intensity of the cosmic rays varies inversely as the strength of the magnetic field, measurements taken in the same latitude but in different parts of the world do not agree. This effect can be explained on no other grounds than that the rays are charged particles, and it is a stumbling block which Dr. Millikan cannot leap. He admitted at a recent meeting of the National Academy of Sciences that if this evidence is fully substantiated, he may be forced to revise his opinions.

He did not make this concession without reservations, however. He maintains that these streams of electrons may not be the cosmic rays themselves, but are an effect caused by them. When the un-

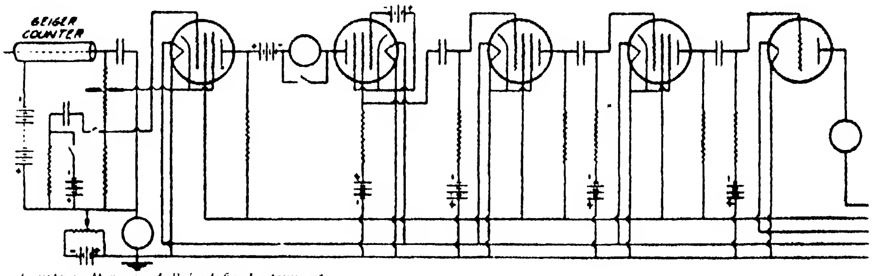
charged photons, traveling with the speed of light, collide with molecules of gas in the atmosphere, they expel electrons, both positive and negative, from the atomic nuclei. These may be the particles, he says, which are influenced by the earth's magnetic field.

This is still a source of contention between the supporters of the two theories. In order to decide whether the electrons are secondary or not, it is necessary to determine their energy very accurately. This can be done with fair precision by the Wilson cloud chamber method. This instrument is an ingenious device which enables scientists to photograph the tracks of particles far too small to be seen. As a charged particle shoots through the chamber, it knocks electrons from the orbits of any gas molecules which happen to get in its way. Then, if the gas is suddenly cooled by expansion, moisture condenses on the ionized molecules, and a photograph shows these tiny drops forming a thin white line along the path of the particle. If the instrument is placed in a magnetic field, the paths will be curved, just as they are in the earth's field. The strength of the field and the mass and charge of the particle are known: the curvature of its path can be measured on the photographic plate, and from these data, its velocity and hence its energy can be calculated.

THE values of the energy are generally expressed in electron-volts, which are more convenient units than ergs or joules. When an electron is placed between two charged plates, it is attracted to the positive one, and its velocity depends upon the difference of potential between them. The number of volts which would have to be applied between two plates to give the electron a certain velocity may be used as a measure of its energy, and this is the significance of the electron-volt unit. Dr. Compton believes he has measured cosmic energies as high as 600 billion electron-volts. Dr. Millikan concedes values only as high as 10 billion electron-volts.

As the cosmic rays come through the air, they are absorbed, and so are less intense at the surface of the earth than they are near the top of the atmosphere. The stratosphere balloon ascensions of the Piccards and the free balloon experiments of Regener in recent years have been made in an attempt to discover just how much absorption really does take place. Compton and Millikan dispute this point as well, Compton saying that the amount of absorption can be satisfactorily accounted for if the rays are electrons, and Millikan insisting that an adequate explanation can be made only if the rays are photons.

The investigation of cosmic ray phenomena has by no means ceased. The exact laws of atmospheric absorption are still uncertain, and further stratosphere flights are being planned and carried out in an effort to clear up the difficulty. Dr. Compton himself is at the present time working on free balloons at the University of Chicago, with which he hopes to make cosmic ray intensity measurements in the near future. Both the balloon and the instruments it carries will be controlled by radio signals from the earth, and it is expected that



Courtesy *Review of Scientific Instruments*

Figure 1: **An ordinary Geiger counter, such as is used for general research in laboratories, for counting ions, consists of a hollow metal cylinder, indicated schematically at the upper left-hand corner, with a fine wire (dotted line) running through it. If connected with an amplifier much like those used in radio sets, the current output may be used to close keys, operate shutters and so on. Such an apparatus as this would count the ions caused by cosmic rays, but it would not indicate the direction from which the rays came. Next, note the double Geiger counter shown on the opposite page, arranged for directional use**

data will be obtained from even higher altitudes than have been reached before.

The Byrd expedition was equipped with apparatus to measure cosmic ray intensities in Little America, while ships and airplanes alike frequently carry automatic measuring devices. The instrument most often used for this purpose is the Geiger double counter, which determines not only the intensity but the direction of the incoming rays. It consists of two glass tubes placed in a line with each other (see figure on opposite page) evacuated so that only a few atoms of gas are left inside. When a cosmic ray enters the instrument, it ionizes these atoms, freeing some of the electrons from their orbits. A charged wire runs through both tubes, which attracts the free electrons. A small current therefore results whenever a cosmic ray passes through the instrument, and this can be made to operate a key or the shutter of a lens. Thus the number may be counted or recorded automatically.

ALMOST every new addition to the knowledge about cosmic rays throws its weight into the balance in favor of the charged particle theory. Scientists now generally believe that at least part of the radiation consists of particles, but they disagree as to how large that part is. Dr. Millikan estimates it as 15 or 20 percent of the total radiation; Dr. Compton classifies all but a fraction of one percent as particles, while Dr. W. F. G. Swann of the Bartol Research Foundation sets an intermediate value of about one third. They all agree, however, that it is very difficult to determine which are the original rays from outer space and which are secondary rays, created when the primaries collide with atoms and molecules in the atmosphere.

The question of the ultimate nature of cosmic rays is by no means decided. Much more research must be carried out before either theory can be accepted with confidence. Until the constitution of the rays is known, their origin can be only a matter for conjecture. Some hypotheses have been advanced, however, which are interesting to examine. Dr. Millikan's atom-building theory attracted a great deal of attention a few years ago. Hydrogen atoms, which are scattered throughout interstellar space, he said, might occasionally fall together to form atoms of the heavier, more complex elements. It has been found experimentally that when such a fusion does take place, energy in the form of photons is radiated. Dr. Millikan's first measurements of cosmic ray energies seemed to check closely with the values he computed, from his hypothesis, but later investigations proved that, in general, cosmic ray energies are higher than can be accounted for in this way. He still believes, however, that if the primary rays are photons, they result from the partial or complete annihilation of atomic mass in space, and the transformation of this mass into energy.

Others have proposed that the explosion of clouds of charged particles from the atmosphere of novae or rapidly expanding stars may account for cosmic rays. Still others look to some cataclysmic disaster in by-gone ages as the explanation. Whether any of these ideas approximates the truth, or whether theorists must search for some solution as yet undreamed of, no one can say.

But cosmic rays may not remain a mystery for long. Science is busy, finding and fitting together the pieces of the puzzle, making clear, bit by bit, its intricate design, and approaching gradually the completion of the picture.

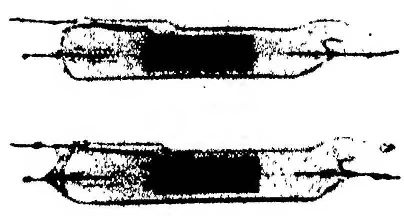
Cosmic Rays*

By ARTHUR H. COMPTON
Professor of Physics at the University of Chicago

WHENCE come the cosmic rays? One of the most significant aspects of the latitude effect [See preceding article.—*Ed.*] is its implication that the cosmic rays originate far beyond the earth's atmosphere. The earth's magnetic field is not strong enough to bend appreciably any radiation produced within the atmosphere before it is stopped by collisions with molecules. Furthermore, the cosmic ray intensity is found to depend upon the average magnetic effect of the whole earth, and to be almost unaffected by "local" magnetic idiosyncrasies which may extend even over a whole continent. This must mean that they feel the effect of the earth's magnetism when yet thousands of miles from the earth's surface.

EXCEPT for deflection by the earth's magnetic field, however, the cosmic rays are found to approach the earth nearly uniformly from all directions. Outside the earth's atmosphere, we fail to find any isotropic distribution of matter within our galaxy where such rays might originate. The extra-galactic nebulæ or space itself would, on the other hand, satisfy the condition of spherical symmetry. Calculations by both Eddington and Lemaître have shown that the probable absorption of a cosmic ray traversing the matter in interstellar space with about the speed of light for 10^{10} years would be wholly negligible. If, however, these rays are subject to the same red shift as that which occurs in the light from the distant nebulæ, the rays originating at distances as great as 10^{10} light-years would arrive at the earth with only a small fraction of their initial energy. If the rays are being continuously produced, therefore, their isotropic distribution suggests that most of them originate in the remote galaxies or in remote space, at an effective distance of between 10^9 and 10^{10} light-years. An alternative would be to suppose with Lemaître that they were formed at the beginning of the expansion of the universe, and have ever since been coursing through space.

Some positive support for this view of the remote origin of cosmic rays is given by the fact that there appears to be an effect on their intensity due to the rotation of the galaxy. According to Stromberg and Hubble, this rotation carries us toward declination 47° N. and right ascension 20 hr. 55 min., at a speed of about 300 kilometers per second—one thousandth the speed of light. If the source of the cosmic rays is outside our galaxy and at rest relative to its center of gravity, calculation shows that at our latitude this motion should cause a diurnal variation, following sidereal time, through a range of the order of 0.1 percent. The best available records of cosmic ray intensity show a variation with sidereal time of about the predicted magnitude, and with its maximum at precisely the predicted time. Though further experiments are necessary before other possible interpretations of this sidereal time variation are ruled out, the complete agreement with the predictions may justify the presumption that it is really due to the rotation of the galaxy. This would necessarily imply that an important part of the rays originates outside the galaxy.



Courtesy the National Geographic Society

What a double Geiger counter looks like. There are two cylinders, each about eight inches long, each with the wire mentioned under Figure 1 on the opposite page, and exhausted of air. Arrangements are made such that no record will be made unless the incoming cosmic ray penetrates both cylinders simultaneously. In this wav the double unit becomes directional, and this is the principle of the cosmic ray "telescope" (which is not really a telescope). Units like the simple one shown above, but in larger groups, were taken aloft in the National Geographic Society-U. S. Army Corps stratosphere flight in South Dakota

How are the rays produced? Of the many hypotheses regarding the origin of cosmic rays, none has received sufficient experimental support to gain general acceptance. Those which assume the primary cosmic rays to be photons appear to be in definite conflict with the observed latitude effect. Also those which would ascribe their origin to transformations of atomic nuclei with resulting loss of mass are unable to account for the huge energies of from 10^9 to almost 10^{12} electron-volts which the more recent studies seem to require for the individual rays. Local or interstellar electric fields have been suggested; but the maintenance of such fields in highly ionized stellar atmospheres seems an insurmountable difficulty. There remain, however, a number of theories which cannot thus be excluded. Prominent among these are Lemaître's hypothesis of "super-radioactive particles" emitted at the initial explosion of his expanding universe. Swann's theory of the acceleration of electrical particles by electromagnetic induction from the changing magnetic fields of "sunspots" on giant stars, and Milne's view that the particles owe their energy to the gravitational attraction of the universe.

ONE of the most fruitful lines of cosmic ray research has been the study of their effects on passing through matter. Especially valuable have been the experiments with Wilson chambers in strong magnetic fields, and the use of Geiger-Müller counting tubes. These and other methods have shown that a complex mixture of secondary rays is excited by the primary cosmic particles.

A prominent feature of the secondary radiation associated with cosmic rays is the occurrence of "showers" of 2 to 20 or more high-speed particles emanating apparently from the same point. These particles are about equally divided between positive and negative electrons. Furthermore, these showers themselves frequently occur in groups, all excited by some "shower producing radiation." This "shower producing radiation," according to studies by Rossi, Blackett, Anderson and others, seems to consist of photons, similar to X rays, produced at the collisions of the primary cosmic ray particles with atomic nuclei.

Our analysis of the composition of cosmic rays is well under way, and from present indications should soon give conclusive results. The "cosmic" origin of the rays, though perhaps not established, appears now more probable than ever. How they originate is still obscure; but increased knowledge of their characteristics has helped to limit the type of hypotheses that are admissible. Of immediate value is the use of these rays as a tool. They have made possible the discovery of the positron, and now afford a means of extending our studies of the properties of matter to energies a thousandfold greater than are available from any other known source.

*Courtesy of *Nature* (London)

For Better Houses

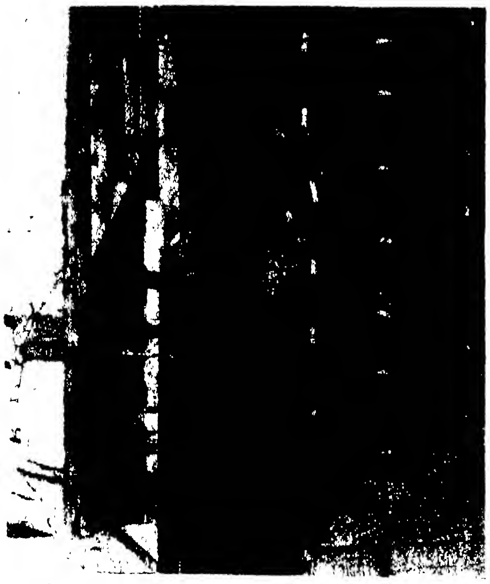
Scientific Materials . . . For Insulation . . . Durability, Permanence . . . Easier Application . . . Slow Growth Explained . . . What The Future Holds

By PHILIP H. SMITH

THE building materials incubator has been hatching new products at such a tremendous speed of late as to leave the casual observer, not to speak of the prospective builder, engulfed, bewildered, and often skeptical of the much touted progress. What materials are substituting and why? Are new products really superior to older ones or are they produced simply to catch the unwary? Why are they coming upon the market in such volume when building is at ebb?

There are several ways to get answers to these questions. Examining objectives will reveal quickly the significance of building materials development. Products usually are not made simply to sell, though there are exceptions; they are made for specific purposes, and delving into these purposes organizes the heterogeneous lot so they can be reviewed and appraised. Once materials are properly lined up, evaluation can proceed.

There are four main purposes which will serve as pegs. They are, to obtain: Better insulation; Greater durability and permanence; Easier application; Elimination of repetitive and overlapping treatment—and hence higher costs.



Panels of pressed cork used with steel framing in the construction of house walls

There are, of course, many lesser objectives which promptly come to mind, but every product on the market or on the verge of commercial introduction ties to one or more of these four points. As a matter of fact the aim is to incorporate as many good points as possible in any single material, and commercial success now hinges on such inclusion.

HEAT insulation is listed first among objectives because it has been given most serious attention, because it has received the most striking treatment, and because it symbolizes perhaps better than anything else the direction of materials research. Dwellings have always been inadequate in the matter of insulation and the progress of building through the centuries has been marked by the slow overcoming of this deficiency. Latterly the concept has been spread that a structure is outmoded if it approximates a heat sieve. Household economy can no longer tolerate heat waste. And air conditioning comes along to provide the final stimulus, since its proper, economical functioning depends upon adequate insulation.

Two schools have grown up in the insulation field. While both aim to keep temperatures constant, one seeks to prevent the conduction of heat through wall structures by using dead air spaces, and the other seeks to reflect heat by providing a baffle. Proponents of the first method provide fiber and cork boards, felts, and insulating wools of the rock, mineral, and glass type; the second group employs aluminum foils.

Great strides have been made toward perfecting insulating boards, although presumably the ultimate is far from being reached. All manner of raw materials are being put to use; practically anything having a fibrous

or cellular structure will provide dead air spaces. Products on the market make available a great variety, some having finished surfaces, others surfaces to take plaster or color treatment. More recently efforts have gone to create a board which will serve as a complete wall, to have—in addition to insulating value—ease of installation, reduction of labor operations, and durability. An example of this type is a board comprising an insulating material sandwiched between slabs of asbestos-cement.

CORK board, comprising granular cork pressed into a solid mass without the use of a binder, is being used in conjunction with steel framing to give a solid insulating wall, lacking only a surface finish. This really carries over the principle of the household refrigerator. Rock and mineral wools, hailed as revolutionary only a few years ago, have come into general use as accredited insulating materials. Progress has been made in evolving wools from the waste products of mines in order to obtain a high grade product at low cost. The better grades are made water-repellent as they should be if maximum insulating value is to be obtained. Glass, too, finds a use here, for spun glass—long hair-like filaments massed in batt form—provides a structure with countless stagnant air spaces.

Known in Europe and there put to practical use before adoption in the United States, aluminum foil has quite recently come forward as an insulating material. Commercial application to homes has followed upon early use in

One of the methods of applying aluminum to walls for insulating purposes: The thin, shimmery sheets are applied to all wall surfaces immediately beneath outer surfacing material to check heat radiation

American naval construction and later industrial uses such as for refrigerator cars, household refrigerators, and steamships. Foil insulation works in two ways—it reflects radiant heat back toward its source and checks the emission of heat from its polished surface. It does for a house much what the vacuum bottle does for its contents. It differs radically from orthodox insulating materials in that it does not store heat, hence a foil-insulated room warms up more quickly when heat is turned on and, conversely, cools off more rapidly when heat is shut off. Whereas fibrous and cellular insulators reduce heat conduction, foils check heat radiation.

One can ponder this distinction between insulators and wonder how foil can be utilized since metal is a good conductor of heat. The manner of installation provides the answer. Foil is applied in several ways but in every case there should be an air space in front of the reflecting surface. One type of application calls for hanging the metal in sheets with intervening air spaces between the inner and outer wall of a structure. Another type employs crumpled foil so that where sheets touch, there will be a minimum contacting area through which heat might be conducted. Still another form uses foil affixed to sheets of heavy kraft paper, to a metal fabric acting as a plaster base, or to gypsum board.

Homes can be efficiently insulated today, for suitable, reliable materials are available. Need has brought them into existence; for home owners are coming to realize that enormous heat losses are unnecessary and that although initial construction costs are higher when insulation is used, in time fuel savings will more than offset the original outlay. B.t.u. heat losses can be reduced from 25 to 40 percent with properly installed insulation, the extent of the saving depending upon the type, size, age, and condition of a house. And aside from cost savings there is the gain of increased comfort for the occupants and longer life for the interior construction—equable temperatures reduce the stresses and strains induced by volume changes of materials.

Maximum insulation means adequate insulation, properly applied; and that involves more than walls and roofs. Plenty of heat escapes through windows and this has led glass manufacturers to make the valuable contribution of double glazing. Storm windows, so-called, have been used for generations but double glazing goes several steps further in accomplishment. This new development comprises two panes of glass set in a single sash with a sealed air space between panes. It takes into account the fact that insulating value varies with the width of the space between panes and provides the proper spacing; it seals this space to make it an effective barrier and dehydrates the air so that moisture and frost formation will be checked or prevented.

INSULATION, while holding the front seat at the building materials arena, by no means monopolizes all the advances. Here we must depart from the classification of purpose since the materials to be reviewed are chosen because they represent the most recent fruit of the laboratory of a significant type.

One can hardly think of a material more basic than cement unless it be wood, and cement has marched along with the procession. The goal of research has been to achieve a control which would give a more uniform product and attention now centers upon finding out what happens in the manufacture of cement, what physical and chemical changes take place in the various stages of production to establish this control. Out of this work the researcher hopes to find a way to make a more durable product and one with a more constant volume, rather than a stronger one. It was established several years ago that the water-cement ratio was of paramount importance in the mixing of concrete and as this fact has been disseminated structures have become increasingly satisfactory. Here the layman has run up against a tangible improvement and, aside from this, the introduction of pre-cast joists constitutes about the only other advancement which has come to his immediate attention.

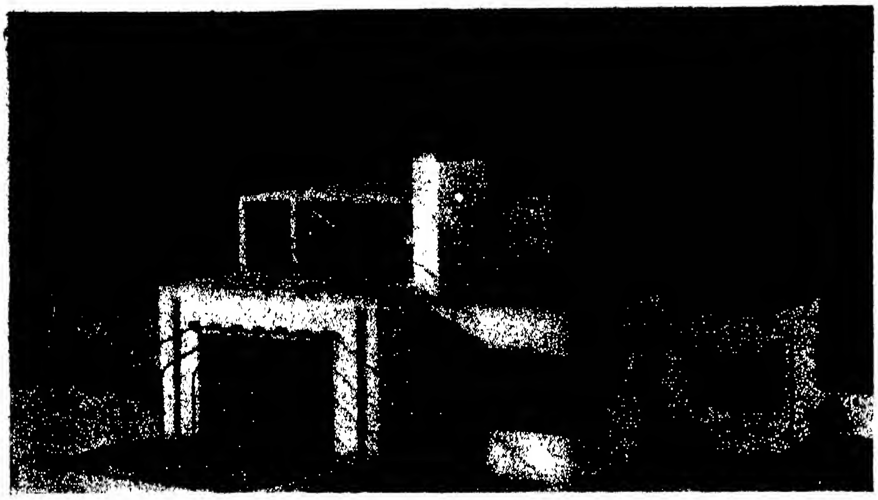
Improvement in the technique of pre-casting permits production of joists in quantity, in stock sizes, adequately strong, fire-proof, and, of course, easy to install. Coupled with the use of pre-cast slabs, entire floors can be made of concrete and methods have been devised which obviate the use of forms. All this means lower costs and widens the range of cement use. Such simplification in the handling of cement points the path of development, for it is in this wise that costs will be lowered, rather than in lower material costs since the emphasis is on improving quality.

ALLIED to concrete in character is artificial or synthetic stone of which several types are on the market. One such synthetic stone is made from naturally occurring alumino-silicates like shales and slates, made to react with an alkaline earth base in the presence of low pressure steam. The principal advantage of the synthetic stone lies in control of size under factory methods. And if waste materials can be used, the advantages are substantially increased. One such waste product stone is now being made from fly ash to show what can be done to produce durable building materials at low cost.

Fly ash results from the combustion of powdered coal and since it is a light

Rock Wool batts, in convenient sizes that are easily cut, are placed between studs

Section of window pane showing double glazing with sealed air space



Model of a house built mainly of a pressed board which, in turn, is composed of processed wood scraps. It makes a livable house in the true "modern manner"

material, formerly having no value, its disposal has always been a power house problem. It is collected from the combustion gases either through electrostatic precipitation or by wet scrubbing, and collection is necessary to prevent it from covering the countryside. Using the reaction between this fly ash and an alkaline earth base, a stone has been produced which is made up of 90 percent fly ash. As yet the stone is in the introductory stage and has been used in the form of brick and hollow back-up units for load-bearing walls. Since this product seems to lend itself well to factory treatment, proponents suggest that the power plant of the future will have a floor directly underneath the electrostatic separators where the fly ash can be fabricated into building materials. This would mean production close to the place of consumption.

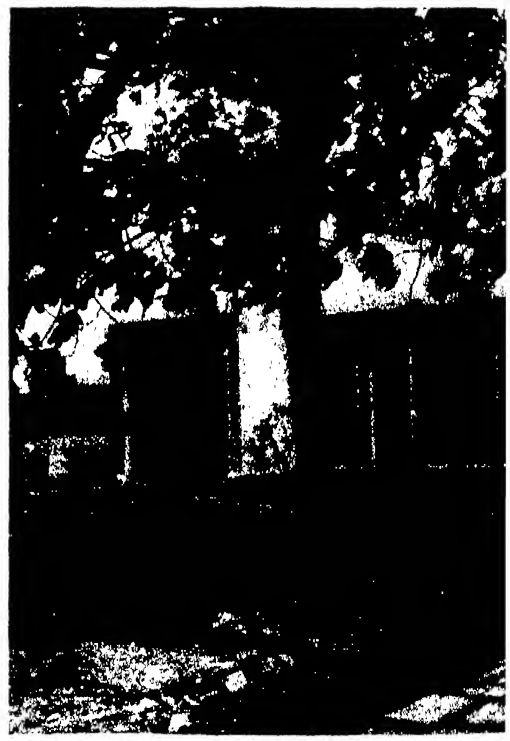
Even as concrete and synthetic stone come in for experimentation to impart qualities lacking, so brick undergoes development to better it and make it suitable for a wider variety of uses. Brick, or we might better say ceramics, reached a high stage of commercial use without the benefit of science, so science now looks back to determine physical and chemical structure with the idea of establishing a control permitting the manufacture of more uniform products. Clays are being studied, so is the firing process, and the net result will be ceramic materials designed for specific purposes. The result of such studies is already manifest in the arrival of lighter weight brick having good insulating properties. The method of manufacture is one of mixing the basic materials with some organic material which burns out in the firing process to leave a multitude of voids[1]. Cork is used, but experimental work considers other substances, and research men are endeavoring to find ways of making the voids, or cellular structure, more uniform.

It is not hard to visualize some very significant results from work with ceramics in the light of present research. It is conceivable that, with the establishment of better control, materials will be developed which will lend themselves to fabrication into wall panels combining more qualities than are to be found in any existing material. Being a ceramic base, such a panel would be fireproof and termite-proof, it could be light in weight and be treated to be water-proof. It would also have high insulating value. This is the sort of material research seeks.

If the goal is not achieved with ceramics it will be reached with some other material, for a great volume of work is being carried on to improve and perfect factory-made panels for wall surfaces. Most of us are familiar with the boards now on the market; those made from wood pulp, wood fiber, cane fiber, plaster, gypsum, and the like. Still newer are the plastics made from synthetic resins[2]. And from this comes resin treatment of woods to make them more durable. Synthetic resins have provided a binder for laminating woods to make the laminations inseparable and the product mold-proof. Waste products come in strongly in the panel board field and the end is not in sight. New compositions are undergoing experimentation which will bring into use such materials as latex, sawdust, and shavings.

Control of volume changes has recently taxed the attention of board producers, having already tackled such problems as finishes, textures, insulating properties, application and durability.

No survey of new materials would be complete without some reference to



A completed house of steel construction, attrac
Its cost was surprisingly low, amounting to only

Laying the gypsum section of one type of "package" home. Long used as a heat insulator in steam plants, gypsum may find wide use in house construction

[1] April 1935 *Scientific American*, page 201.

[2] January 1935 *Scientific American*, page 5.

metals, but the mention must needs be short for extended comment has been made in previous articles[8]. In home construction, the metals have played a minor part. Stainless steel, admirable from the standpoint of corrosion resistance, and aluminum which boasts the advantage of light weight, both make their major contribution in commercial building. What we do find is a slow but steady growth in the use of steel for framing and for floor joists, and some use of steel sheets for exterior walls of houses.

But let us halt at this point, having sensed somewhat the direction of building materials development and its ultimate objectives. Let us consider another step which is going to be taken very promptly. This step is the elimination

Pre-cast concrete joists are of comparatively light weight an stalled. Properly made, they should never shrink. They are full

ortable, and up-to-the-minute in every respect. rs, including a winter air-conditioning system

of repetitive and overlapping treatments which are so much a part of building operations and so wasteful.

The elimination of wasteful operations is very largely a problem of material design, but it also involves integration of materials and labor operations. What many far-seeing producers of materials appreciate is the possibility of so manufacturing items that overlapping is greatly minimized. This calls for more prefinished materials and development of installation technique to eliminate the mess which normally accompanies construction. It means, for example, fasteners which eliminate the puttying of nail holes; it means floors which do not have to be refinished once they are laid, just because of the tramping they get while the rest of the house goes up. It would mean that when a particular craft had made its contribution there would be no returning to the job to repair the troubles created by another craft operation. Such progress is conceivable and is, indeed, approached as materials become standardized yet flexible in use.

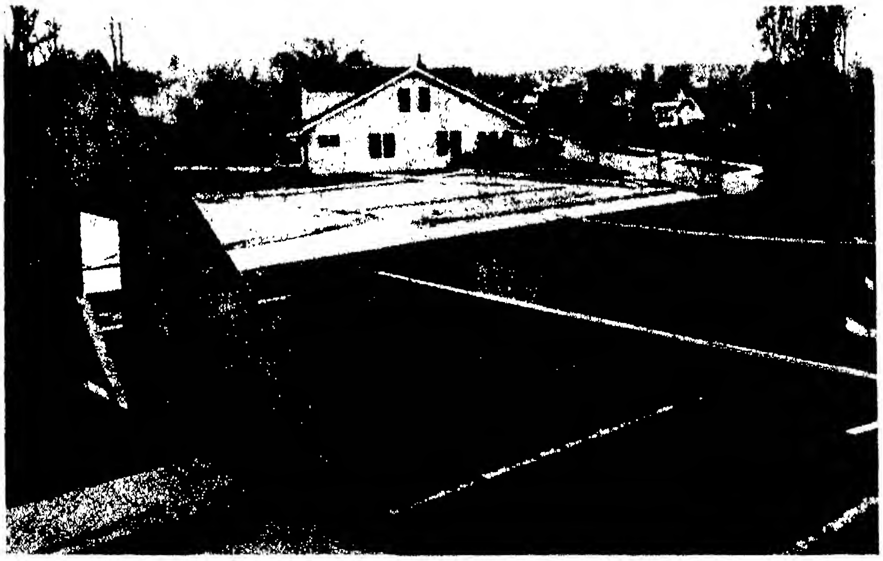
IT is valid to say that more progress will be made toward solution of the above problem as the researcher and the chemist come out of their laboratories to view the building field as a whole, and as they become more conversant with its practical problems. This they must do if the products of their labor are to make their way in an increasingly competitive market. No building material stands wholly alone; it must fit and function with many others and to the degree that it does so, it comes to your attention and my attention as prospect and critic and so into ultimate use.

With many more thousands of minds trained upon the building industry than ever before, advancements are bound to come to light more qui last analysis it will be the new who will be most respo their quick acceptance and u

The architect is sometimes cr for his delay in adopting new mater But the criticism is hardly justified. custodian of the consumer's bank roll it is not his function to experiment. The responsibility for prompt placing of advancements before the consuming public goes back to the chemist and those surrounding him. Tests must properly take place in the laboratory or under controlled conditions and then the translation work begins. Good translation means quick consumer benefit.

Because the chemist and the producer are accepting this responsibility more and more, you will see in the next few years much more rapid progress in this enormous field which has existed ever since man sought shelter from the elements.

Illustrations courtesy: American Houses, Inc.; The Corkanstele Company; The Masonite Corp.; Portland Cement Assoc.; The Standard Lime and Stone Co.; The Thermopane Co.; International Vermiculite Co.



Erection view, from above, of a house having cellular steel walls, in the spaces of which can here be seen Vermiculite for insulation against heat conduction

[8]*Scientific American*, July 1935, page 20, and August 1935, page 66.

.EAD!

's Come It Is the Logical Time , .not Cut, the Funds for Research . . . Research Millions Are the Seeds of Billions

By T. SWANN HARDING

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..boratory research
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.. singing a sort of song-
' a ran over and over again,
'isly, "Cut the overhead!"
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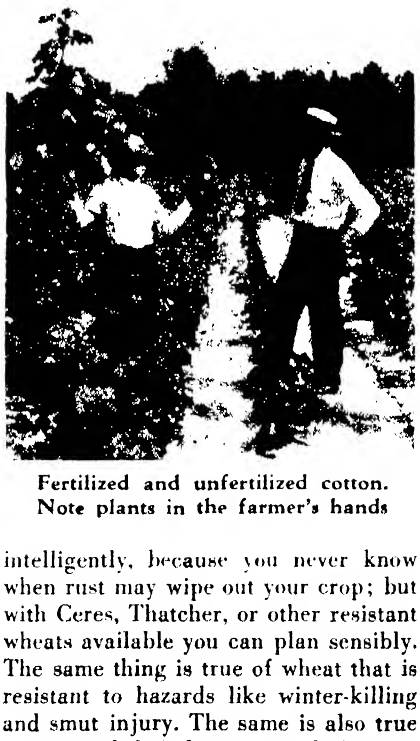
ral Government began to accumu-
:. a deficit, the same sort of people
began to cry "Cut the overhead! Fire the scientists! Discontinue all research by the Government, for it has only gotten us into trouble. Cut the overhead!" Yet the cost of all the research carried on by the Federal Government never reached above 20 millions a year, and has usually been less, while conservative estimates hold that it has paid from 250 to 500 percent dividends.

What is 20,000,000 dollars? Two thirds the cost of building the *Queen Mary*, and less than that of a first class battleship! In 1930 ten companies in the United States could afford to spend more than two millions each for magazine advertising alone. This is no adverse criticism of advertising or of the expenditure but it does seem that the same country as a whole could afford to spend 15 or 20 millions a year for Federal Government research.

The business man's answer is "But look what it got us! The Department of Agriculture spends most of that money on research, and look at the mess it got the farmer into, showing him how to increase production. Now it has to go around and tell him to produce less, just because of research." Yet when you consider research which lessened plant diseases, for example, the result of plant improvement has been, over long periods of years, rather to prevent ruinously low yields in occasional years than to raise the general level of production.

SUCH crop improvement tends to stabilize production. This permits more definite, scientific agricultural planning. Take stem rust, caused by a fungus, and which has long taken an enormous toll from the nation's wheat crop. The disease, like whooping cough in humans, is not of equal severity in all years. Some years it is negligible, some years so devastating that it wipes out the wheat crop of entire sections. But agricultural scientists can breed wheat varieties resistant to stem rust. These reduce losses almost to the point of elimination, in some cases.

With susceptible wheats it is impossible to plan a wheat production program



Fertilized and unfertilized cotton. Note plants in the farmer's hands

intelligently, because you never know when rust may wipe out your crop; but with Ceres, Thatcher, or other resistant wheats available you can plan sensibly. The same thing is true of wheat that is resistant to hazards like winter-killing and smut injury. The same is also true of oats and their losses to such diseases as crown rust, stem rust, and loose and covered smuts. Breed resistant varieties and you stabilize production. Whether the wheat or oat quota is high or low it is obviously ridiculous for farmers to raise these crops for disease to annihilate.

Rust and smut not only decrease the yield but also the quality of oats and wheat. Gains in quality or resistant varieties are often as important as increased production. A few years ago practically all the wheat from some shipping points in the Pacific Northwest was very smutty; the consequences were heavy dockage and low price. But with the use of smut-resistant varieties like Ridit, Albit, and Oro, most of the wheat from these same regions is smut-free and unpenalized.

The newer strawberry varieties produced by research are of finer quality than those already existing. Alfalfa wilt not only causes losses of the crop but it shortens the life of established alfalfa fields. Dozens of new varieties of fruits and vegetables have been developed which are simply of better quality than those replaced.

Other altogether new crops have been introduced, like Korean lespedeza. This plant was introduced only a few years ago. Now we grow 15,000,000 acres of it because it can withstand such unfavorable conditions as the heat and drought of 1934 far better than our already common legumes. It can provide grazing when other crops fail. Again the factor of stabilizing agricultural production is important.

THEN there is the question of maintaining an agricultural industry in a section where plant diseases menace the very existence of the crop. In 1922 the lettuce-growing industry of the Imperial Valley of California was menaced by mildew and brown blight. The Department of Agriculture and the California Experiment Station got together and produced strains of lettuce resistant to both diseases. They then transferred this double resistance to a number of lettuce varieties with other good characteristics, and now 90 percent of the commercial lettuce grown in the southwest is of strains produced by this research.

There is another oddity about lettuce. Lettuce seed have to have a period of dormancy before they will germinate. Seed produced in the regular lettuce-seed sections of Northern California is harvested in August and cannot be used the same fall in the Imperial Valley.

with clay to produce definite parting lines. Around this model is placed a mold form and a plaster mold is poured. In the second step the plaster mold is split and removed from the model. At this point the clay remains on the model surface and is carefully stripped off as the third general step in the procedure. In the fourth step the plaster mold is reassembled around the model and the cavity which was formed by the clay is filled with glue. Water-soluble glue is used because of its elasticity and its ability to follow all the intricacies of the model, thus making a perfect "negative" and producing an exact replica of the original in reverse.

The model and mold, in the fifth step, are again taken apart after the glue has set. To make doubly sure that nothing will go wrong, the sections of glue are held in place with small wire clamps. At this time the face of the glue is coated with fluid wax of sufficient thickness to correspond with the desired thickness of the metal in the finished casting. The sixth step consists of re-assembling the plaster mold with its glue and wax shells. As shown in the photograph of this step, rods are set in place to support the core, which is poured in completion of the seventh step. At this point the wax coating becomes transferred from the glue surface to the new core, and the form with its glue facing is removed from the core and discarded.

THE wax-coated core is now suspended in a suitable wooden form by means of wires which are later removed. Around the core is poured wet plaster, and suitable provisions are made for pouring-sprues, gates, and risers, so that the poured metal may reach every point of the figure as soon as possible. This constitutes the eighth general step in the process, and completes the drag or lower section of the mold in which the metal will later be poured.

The whole mold is now ready for baking and drying, which is carried on at carefully regulated temperatures in the neighborhood of 500 degrees, Fahrenheit. At this temperature the wax melts and runs out through openings provided. A modern refinement in this process is the installation of thermocouples in the plaster in order to determine the exact temperatures at all times and thus remove the risk of cracking the plaster. The dried and baked upper and lower sections of the mold are shown in the photograph illustrating the ninth step.

Sixth Step. **Plaster mold with glue and wax shells re-assembled for making the plaster core**

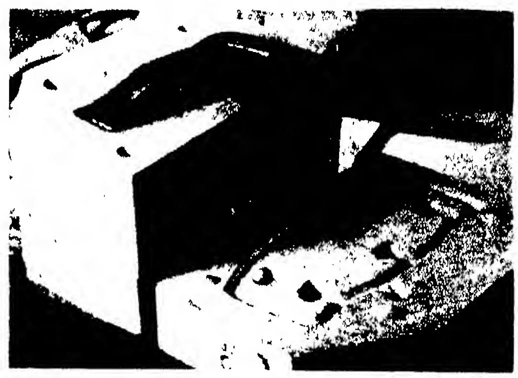
The mold is now made ready for the molten metal, the tenth step in the process, by providing proper supports as shown. The metal, at exactly the proper temperature, is poured into the mold and forced into every crevice by gravity. After the metal is cast, it is allowed to cool, whereupon the mold is broken open and the finished casting removed. The casting as it comes from the mold is shown in the photograph of the eleventh step. Artists are now set to work chasing the surface, cutting away useless agglomerations of metal, pointing up flat surfaces, sharpening corners, and giving the whole piece a feeling of crispness.

The surfaces of the finished aluminum castings for the Navy and Marine Memorial were finished by the Alumilite process to produce an oxide coating many times thicker and more resistant to weather than the natural oxide coating which is produced when aluminum comes in contact with the air. This oxide coating is impregnated with metallic pigments giving the statue the desired colors, ranging from varying shades of green in the waves of the Memorial to a golden yellow that approximates the color of sunlight.

IN producing the Alumilite finish, which can be obtained only on aluminum, the castings are subjected to various types of buffing, burnishing, polishing, and brushing, to lend character to the surface texture. Then the prepared metal is immersed in a special sulfuric acid bath and a current passed through the electrolyte. The piece to be coated is used as the anode, while the lead-lined tank containing the electrolyte acts as the cathode. The process is frequently referred to as the anodic oxide process.

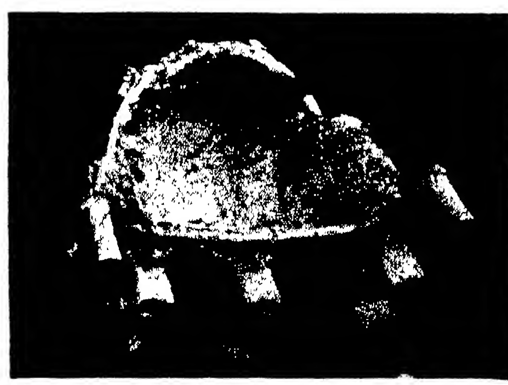
Seventh Step. **Plaster core with wax facing**

Eighth Step. **The drag half of the mold**

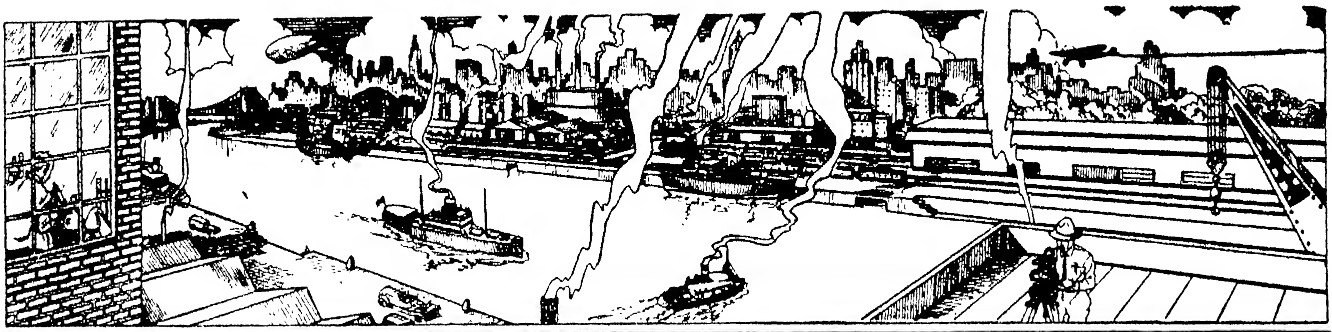


Ninth Step. **Drying cope and drag sections**

Tenth Step. **Mold ready for the metal**



Eleventh Step. **Casting ready for finishing**



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

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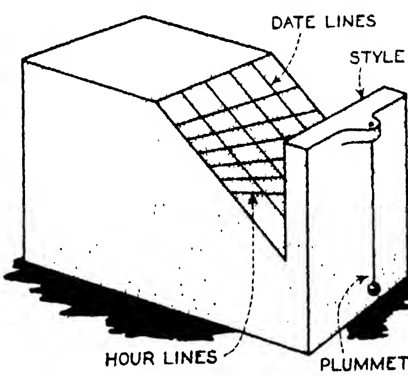
An Ancient Egyptian Sundial

IN ancient Egypt the methods of telling the time were by klepsydras or water clocks—water running at a controlled rate out of a small opening—by instruments for observing the stars, and by sundials. Sundials were of three varieties, which measured respectively the height of the shadow, its length, and its direction. The fragment of a sundial shown in an accompanying photograph is in the Metropolitan Museum of Art, New York, and belongs to the second of these varieties. The sketch is made from one furnished by the Mayalls, authors of a recent series of articles on sundials, published in this magazine, from a written description in the *Bulletin of the Metropolitan Museum of Art*. The height of the fragment is $3^{11}/_{16}$ inches and it is made of marble.

Fragment of an Egyptian sundial

"The gnomon was a perpendicular block rising at the foot of the sloping face, its height and width being the same as those of the latter," Nora E. Scott writes in the *Bulletin*. "On one side was an arrangement whereby a plummet could be hung so as to swing free of the base. The instrument was put down on a flat surface, and whenever it was to be used, was turned so that it faced the sun directly. The shadow of the gnomon then fell upon the face. The spaces marked off by the lines running from top to bottom of the face showed where the shadow was to be read during the different months of the year, starting with the summer solstice at one edge and turning back again with the winter solstice on the other. The oblique lines are for the hours. At six in the morning the shadow would strike the top of the dial; as the sun rose higher the shadow would decrease in length until at noon it touched the lowest line; it reached the top of the dial again at six in the evening.

"An inscription once ran completely around the base of our dial. With the exception of a probable pun (the word used for 'life' can also mean 'time') nothing is said of the dial itself. The text is a prayer that various gods should grant to the scribe Pa-si-Geb, son of Tehuty-kay, prosperity and health, a long life, and a good and beautiful old age."



Drawing showing how the Egyptian sundial appeared. Such a dial should be simple to construct

Water Softener

SODIUM hexametaphosphate has been found to possess properties that make it a useful adjunct to soap when washing with "hard" water. B. H. Gilmore, of the Mellon Institute of Industrial Research, has conducted an extended investigation of the rôle of this salt in sequestering calcium and magnesium ions as they affect detergent operations in which soap is used or formed. By removing these ions from solution without precipitation, the curdling effect of hard water upon soap is completely inhibited, and all of the soap used in washing operations is held in solution to exercise its full detergent effect. Sodium hexametaphosphate is recommended for use in laundering, in mechanical dishwashing, for cleaning the foliage of evergreen shrubbery, as a veterinary wash for the removal of medication, and for pet-washing in general.—*A. E. B.*

Laboratory Tests for Rugs

IN the manufacture of rugs, modern science has contributed largely to the production of floor coverings that will give the best service under trying conditions. In no small measure has this been made possible by the application of laboratory tests to the materials and dyes used, as well as to the finished product. For example, in one rug factory, a constant check is kept on the colors of dyes used, and when a new shade is being sought, dyed samples of yarn are exposed to the action of ultra-violet light for varying lengths of time. Thus the "sun-fast" quality of the dye is determined.

Courtesy Alexander Smith

How long will a rug wear?

For testing rugs for resistance to wear, the ingenious machine illustrated in these columns is used. A sample of the rug to be tested is placed on a rotating table and against its surface are pressed two large leather-surfaced wheels, turning in op-

posite directions. This action simulates conditions to which the rug will be subjected in use, but on a much more rapid scale. At intervals during the test, instruments measure the amount of wear that has been incurred. Comparison of records will show whether or not the materials used are up to the desired standard.

PINE PAPER

SOMETHING like 70,000 cords of slash pine will be used yearly in a new 4,000,000-dollar paper plant in the South, which will make its paper by the process developed by Dr. Charles H. Herty, discussed in these pages last year. Its daily output will be about 120 tons of pulp for kraft paper and bags.

Home Garbage Grinder

LARGELY through the work of scientists and engineers, the time-honored ash can is being eliminated from American homes, and now the same combination has started a drive against the garbage can. An electrical device to be installed beneath the kitchen sink for the purpose of grinding the waste food and quickly disposing of it through the drain pipe into the sewer system has been developed by engineers of the General Electric Company.

Driven by a ¼-horsepower electric motor, which takes current from the ordinary 110-volt house circuit, the grinder will shred all types of waste food, including bones and other hard substances except bottles and cans. Reduced to a fine pulp, this is flushed by water into the sewer and carried away as part of the sewage stream.

The water used in the grinding and flushing process is almost negligible. It has been estimated by engineers of the General Electric Company that in any normal community the increase in the use of water because of this device will amount to but 1 percent. In the average family the grinder will operate not more than five minutes a day, and its average cost of operation per month will be about one half that required for operating an electric clock.

The home garbage grinder in use

Operation of the grinder is simple. Directly beneath the sink is a convenient projecting handle by which the hopper of the grinder is closed and the motor is started. It is sealed against leakage and the grinding knives are made of Carboloy, a metal next to a diamond in hardness. The unit weighs about 75 pounds and can be installed under any style of sink as a part of the outlet plumbing. When not in use the hopper inlet is covered by a perforated cap, leaving the sink bottom flush and in condition for ordinary use.

PROGRESS In This Age Of Science

As Told to Scientific American

By WILLIAM S. SHIPLEY
President, York Ice Machinery Corporation

AIR CONDITIONING has been termed an "infant" industry, by reason of the fact, no doubt, that according to the calendar it can count its birthdays at not many more than 25. Within the past 10 years, however, the conditioning of air has progressed to the point where it must be recognized as an exact science. In the brief span of a single decade, air conditioning has revolutionized many industries. It is, in fact, an industry in itself today, which affects and benefits countless industries. The story of the development of air conditioning in its widespread industrial and commercial applications is a record of constant improvement, of continuous refinement in equipment, of constant striving toward the goal of perfection in equipment and reliability in operation. Today, the list of industries in which air conditioning finds new and profitable applications is steadily widening.

It was early in 1914 that certain far-sighted motion picture men realized that the true destiny of air conditioning lay not only in its far-reaching industrial achievements of that time, but more in the protection of human health and the assurance of human comfort. Others, quick to see the value of its application to human comfort, carried this new idea into other fields, with the result that today we find air conditioning on our railroads, in office buildings, homes, hotels, restaurants, hospitals, and even far down beneath the earth's surface, in gold mines. Railroads, theaters, and retail stores have found a new lease of life, with definite evidence of growth which can be traced directly to the benign influence of conditioned air. Wherever men and women work, play, eat, sleep, travel, or congregate, air conditioning plays a part in their comfort, and in the protection of their health. And in the rapidly increasing range of comfort applications many men are finding employment, not only in the building of air conditioning equipment, and the installation of that equipment, but in the field of scientific research, striving always toward the goal of a wider and more general application of this so-called "infant industry." In carrying out the feature of human comfort to its ultimate conclusion, the possibilities of air conditioning are tremendous.

Fever Treatment For Blindness

ARTIFICIAL fever treatment is proving to be a new weapon in the war on blindness and is expected to be a means of preventing one of the commonest forms of this affliction. Patients whose vision was restored by this treatment combined with drugs were reported by Drs. Arthur M. Culler and Walter M. Simpson of Miami Valley Hospital, Dayton, Ohio, to the American and Canadian medical associations.

The patients had become blind because of syphilitic infection. This disease causes from 10 to 15 percent of all blindness, Dr. Culler said. In some cases, improvement began after one or two treatments and the patients recovered useful vision. In cases in which atrophy or other permanent damage had occurred, the fever treatment did not appear to help any more than other forms of treatment. As most of the 58 patients had failed to respond to other forms of treatment the results were considered satisfactory.

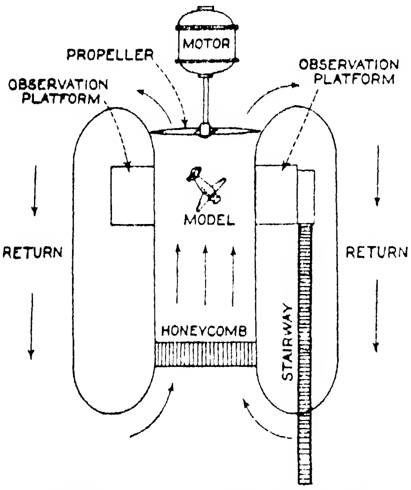
Importance of beginning fever treatment in the early stages of syphilis in order to prevent blindness was emphasized by Dr. Culler. The artificial fever treatment has already been found useful in the mental disease which results from syphilitic infection, it was pointed out.

The patients in the series reported were given 10 treatments of five hours each with temperatures above 105 degrees, Fahrenheit. Skill in the use of artificial fever has progressed to the point where most patients do not need to remain in the hospital. When the five-hour period of fever is over, streams

of cool air bring the temperature down within 30 or 40 minutes. By using new air-conditioned fever cabinets, temperature and humidity are so controlled that no serious effects are suffered.—*Science Service.*

A Free Spinning Tunnel

VISITORS to the recent Langley Field conference were particularly impressed by the installation of a free spinning tunnel, patterned after a similar tunnel at Farnborough, England. As shown in our sketch, the tunnel is vertical and of the double return type. Its working portion is a cylinder 15 feet in diameter, and 27 feet high. The air, drawn upward by an electrically



Vertical free spinning wind tunnel

driven propeller, returns through a circular screen at the lower end of the cylinder, and its speed can be varied between 15 and 50 feet per second. At the top of the cylinder, an observation platform is built around the tube, to which approach is made by a staircase in the return section. Models are very carefully constructed of balsa wood, with a span of 2½ to 3 feet, and are ballasted to give the same moment of inertia distribution as in the full scale machine. These models are equipped with clockwork mechanisms which can be made to actuate the rudder or elevator or both through varying angular displacements, after varying periods of time, and with different rates of displacement.

The technique of experimentation is very simple. The model is pivoted at its center of gravity on a spindle attached at the end of a long pole, which is inserted into the tunnel, and is exposed to the upward air flow. Under the action of a displaced rudder, the model assumes a certain rate of spin. When the upward air speed has attained a sufficiently high value, the model rises from its spindle in a spinning attitude and remains hovering in the air flow, while the pole is withdrawn. The vertical velocity of the air now represents the rate of descent in a spinning nose dive. The model continues to spin about the axis of the vertical wind tunnel and does so with remarkable regularity. All the conditions of a spinning nose dive are thus accurately represented. When the rudder or elevator is displaced by the clockwork mechanism, the model, if it recovers from the spin, goes into an ordinary nose dive, its rate of vertical descent becomes higher and it drops instead of continuing to hover, and is caught in a netting below the experimental section.

For a designer this is a vital experiment. If his model recovers from the spin and drops into the netting, his painful efforts are successful at least as far as spinning characteristics go. If the movement of the rudder does not check the spin, he has to try again.

While the new method is more qualitative than quantitative, it will be of great value. It is far more logical to make an experiment in a free spinning tunnel than to ask a test pilot to spin the full size machine a number of times, and see if he can come out of the maneuver. Many a pilot has been killed when his machine refused to come out of a spin and his parachute did not function or became entangled under the difficult conditions presented to him. —*A. K.*

AN AIRPLANE'S LIFE

WE think of airplanes as ageing even more quickly than automobiles, yet the Bureau of Air Commerce, Department of Commerce, says that the useful life of an airplane frequently exceeds five years. As many as 169 civilian airplanes now in service in this country were built in 1926 or before.

Cost of Aviation Insurance

IT is generally believed that insurance is one of the reasons for the relatively high cost of private flying, and it is gratifying to learn from Jerome Lederer, Chief Engineer of Aero Insurance Underwriters, that aviation insurance rates have declined and that aviation insurance is far from being the most expensive protection which can be bought. The comparative figures that follow are convincing in this regard:

Fire on buildings of combustible materials, 4 to 5 percent. On airplanes the rate is only 3 to 3½ percent.

Windstorm and theft. On automobiles the rates range from 2½ to 6½ percent. On airplanes the average rate is 1 percent.

Crash and Collision. For automobiles rates range from 2 to 24 percent, depending on the city. For airplanes, rates throughout the country run from 10 to 18 percent.

Liability and Property Damage. For taxicabs, combined protection costs about 623 dollars. For airplanes, the two items are covered by about 377 dollars.

The aviation insurance rates were very much higher in 1926—in fact, prohibitively high. Since insurance rates are a reflection of the best opinion as to airplane safety, this decrease in costs and this favorable comparison with other forms of insurance are very satisfactory.—*A. K.*

An Anti-Torque Propeller Drive

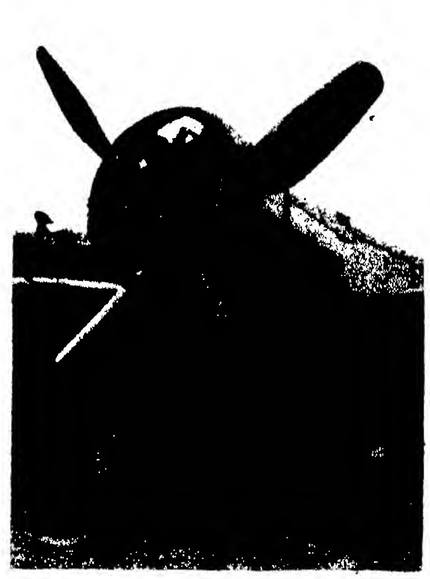
THERE are three difficulties inherent in the transmission of the engine torque or turning moment to the propeller. The torque has to be resisted by the airplane, so that the wing tips on one side must be given more incidence and lift than on the other; this means a delicate process of "rigging" the airplane. The difference in lift of the wing tips also means a difference in drag, and hence the vertical fin has to be offset to counteract the turning tendency thus introduced. If the fin is correctly offset to trim the ship with power on, then it is *not* correctly trimmed for power off—and it is evidently undesirable to have the ship at one time in trim, at another time out of trim. Finally the impulses of the motor are not uniform, and hence the torque of the engine transmitted to the airplane sets up vibration or flutter.

These difficulties are particularly serious where the airplane carries a very powerful engine in proportion to its size and weight. In the Schneider Cup Races, the only way to take up the engine torque was to place one float of the seaplane further away from the center than the other, and to put all the fuel in one float. On a land plane this is impossible, and with very fast racing planes it is hazardous to give full power on the ground because of the tendency of the plane to tip or roll.

Charles L. Brown, an oil jobber of Missouri, belongs to that typically American class of practical men, who, without lengthy technical studies, construct and experiment and invent by the aid of native ability.

He has devised an engine in which these difficulties are removed, has installed it in his own home-made airplane, and flown the combination successfully.

Mr. Brown employs an air-cooled engine of conventional design, in which the crankshaft drives a right-hand propeller in the usual fashion. But the engine itself is mounted in a hollow steel housing, which is mounted on two ball bearings and is free to



How the engine and two propellers are arranged for anti-torque drive

revolve. The engine rotates in the opposite direction to the front propeller, and with its casing two rear propeller blades, of opposite pitch, revolve in a contrary direction to the front airscrew.

The engine, the oppositely rotating propellers, and Mr. Brown's small plane are shown in our photograph. Difficulties of fuel supply and lubrication have been met—they were no more difficult than those offered by the rotary engines which were so widely employed before and in the early stages of the World War.

It can be readily seen that with this arrangement, the power of the engine is

divided between the two propellers and the torque effects neutralize one another.

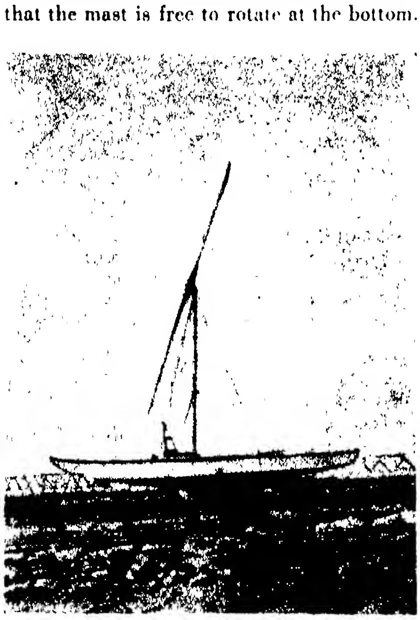
Some sacrifices have to be made, of course. Thus a four-bladed propeller or a combination of two two-bladed propellers is apt to be slightly less efficient than a straight two-bladed airscrew. Also, the rotating engine offers some mechanical difficulties of its own. But in addition to the advantages cited above the following has to be taken into account: The arrangement works as the equivalent of a gearing down of propeller speed, without the use of gears. Thus the engine may be firing 2000 times a minute, giving the equivalent of 4000 revolutions per minute in the conventional motor, yet the two airscrews will only be turning at 2000 revolutions per minute. The advantages of gearing down the propellers are, of course, well known to our readers. —*A. K.*

The mast of the gyroplane sailboat is rotated by a simple control

The Gyroplane Sailboat

THE Wilford gyroplane boat, which has already been briefly described in our columns, has now given definite proof of splendid maneuverability, ease in handling, and real speed. The rotor is 20 feet in diameter and the chord of the two blades is 15 inches. The blades are constructed of heat treated steel spars with dural ribs and cloth covering, the construction being analogous to that of an airplane wing. The blades weigh about 15 pounds each; the rotor hub about 30; the mast and rigging approximately 80 pounds; making the total weight of rigging from 140 to 150 pounds. The ordinary sail rigging of the Star boat which has 280 clear feet of sail area is about ½ pound per square foot; therefore, the weight of the gyroplane rigging is substantially the same as that of the ordinary sail.

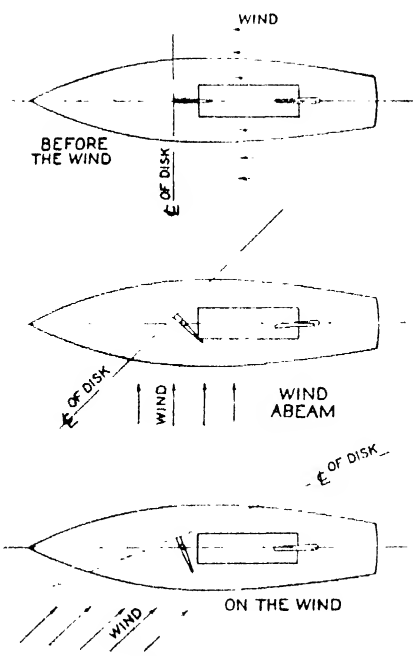
As can be seen from the photographs, the two-bladed gyroplane rotor is mounted at an inclination of about 17 degrees to the vertical mast. At the top of the mast and at the center of the rotor there is an axle about which the rotor is free to rotate. The axle is rigidly mounted to the top of the mast in a thrust bearing. The mast supporting the rotor is braced by wires attached to the thrust bearing in such fashion that the mast is free to rotate at the bottom.



The gyroplane sailboat under construction. Note rotor-blade angle

The mast is also mounted on another thrust bearing at the deck level. This mast can be moved by a handle and fastened in steps provided at every six degrees of rotation.

The rotor, just like an airfoil or sail, has elements of lift and drag, the lift acting at right angles to the resultant wind which is composed of the forward motion of the boat and the direction and magnitude of the natural wind. The various positions of



Angle of the gyroplane rotor is changed to meet wind conditions

the rotor sailing at various angles to the wind are shown in the three sketches.

When coming to a dock the brake is put on and the boat slides in without flapping of sails or bouncing of booms which is customary to yachts worked with sails. Operation with the rotor is much easier than with sails because there is no need of pulling up ropes or of putting up and furling sails.

Tilting the rotor out at the bottom gives clearance for staying the mast in all directions, keeps the rotor disk far away from the cockpit, and eliminates the hazard of occupants being struck by the rotor.

We have often had occasion to explain the action of the Wilford gyroplane rotor, but it may not be out of place to reiterate very briefly the fundamentals of autorotation involved.

It must be assumed that a certain small velocity of air passes through the rotor disk, and that the blades are rotating with sufficient velocity so that the resultant angle of incidence is below the stalling angle of the blades. Under those conditions the lift acts at right angles to the resultant air and the drag with a good section is so small that the resultant air force lies slightly in advance of the axis of rotation. As long as this force lies in advance of the axis of rotation, the rotor will keep on autorotating and its autorotation speed will be limited by the reduction of the angle of incidence to a point where this resultant lies on top of the axis of rotation. —*A. K.*

A Plea for Compression-Ignition Engines

IN a scholarly paper read before the Society of Automotive Engineers by Kenneth A. Browne, on the subject of compression-ignition engines, there is much food for thought on the future of these power plants.

It is sometimes stated that fuel economy in airline operation is unimportant. Reliable statistics for the year 1934 tell a different story:

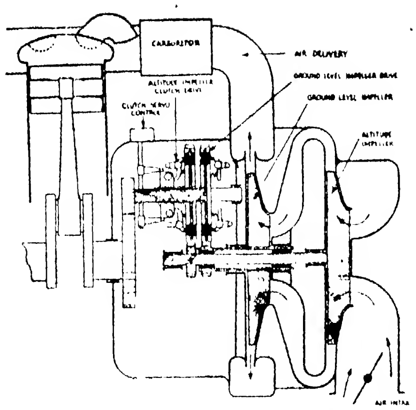
Number of Passengers	537,637
Miles Flown	42,622,619
Gasoline Used, Gallons	21,991,782

The average number of miles per gallon is thus 1.94. Passenger miles per gallon are given as 7.23. Figuring fuel costs at 11 cents per gallon means that fuel costs are 1.52 cents per passenger mile. The average airline fare in the United States is six cents a mile.

Thus the fuel cost is 25 percent of the passenger revenue. There is no doubt that increase in engine efficiency and the use of a cheaper fuel would help transport lines considerably.

In transatlantic operation, saving in fuel would be even more important. At present, non-stop operation of the large flying boats would be possible only with an insignificant pay load. There would be an immediate change in the situation if fuel consumption were cut down on the long over-water flights.

Now greater fuel economy than that of



Diagrammatic view of the two-stage supercharger as used by Wiley Post

the gasoline engine has already been obtained with the Junkers Aircraft Diesel engine, the Jumo, and with experimental examples (in the form of single-cylinder engines) of compression-ignition engines. In the compression-ignition engine only air is compressed in the cylinder, the fuel being injected just a little before the end of the compression stroke. The fuel mixture ignites itself, and the fuel injection equipment is simpler and at least as reliable as the combined ignition and carburetion equipment of the gasoline engine. Detonation or knock need not to be feared at much higher compression ratios than in the gasoline engine, and this makes for efficiency and eliminates the use of special high-octane rating, expensive gasolines.

Why, then, is the use of the compression-ignition engine lagging behind?

First, because reliable pumps for high-speed fuel injection have become available only quite recently. Second, because so much development work and investment have gone into the aircraft gasoline engine that there is a natural hesitation to switch to another type of prime mover. Third, because the compression-ignition engine requires much more excess air for efficient operation, and this means that for the same power the cylinders are larger and the over-all weight higher than for the gasoline engine. And the airplane designer seeks light weight above all things.

There is a way of making the compression-ignition engine lighter. Since this type aspirates and compresses air only, it lends itself admirably to the two-cycle principle—whereas in the gasoline-carbureter engine the two-cycle principle is accompanied with much waste of fuel. With compression-ignition, the fuel is injected *after* the scavenging is completed, and the waste of new gas is eliminated. With two-cycle operation, there is a power stroke every revolution, and hence more specific power for a given size and weight of the motor.

Mr. Browne is quite right, therefore, in advocating intensive development of the two-cycle, compression-ignition engine. Here is his list of specifications which many inventors, engineers, and operators will study with interest:

1. Two-cycle operation.
2. Adaptability of design up to 1500 horsepower. (For transatlantic work in particular there is a crying need for a large engine.)
3. Fuel consumption at cruising speed of only .35 pounds per horsepower-hour (as compared with .52 pounds for the usual type of aviation gasoline engine).
4. A weight of only 1.5 pounds per horsepower.
5. Air-cooling.
6. Geared-down propeller.
7. Starting to be accomplished without glow plugs.
8. Either individual cylinder injection pumps or dual unit pumps.
9. For major overhauls, an interval of 1000 hours.
10. Minimum engine life of 4000 hours.
11. Engine to be capable of operating on a good grade of bunker or heavy fuel oil.—*A. K.*

A Two-Stage Supercharger

IN describing Wiley Post's altitude flight some months ago, we mentioned that the engine supercharger was in two stages. One supercharger is insufficient for maintaining pressure at very high altitudes; the blade tips in a single stage supercharger would have to revolve so fast to produce the necessary pressure as to be moving at a speed higher than that of sound (750 miles an hour) in which case efficiency and effectiveness would both be lost.

Now, thanks to *Flight* (London), we are able to show a diagram of the jealously guarded design employed in the two-stage supercharger. Apparently this design is due to the French firm of Farman Brothers, and Wiley Post's apparatus was built under license from this firm. Farman Brothers have themselves built such a two-stage supercharger for the Soviet Republic, and it has undergone successful tests, with speeds changed 250 times without reducing the speed of the engine and without sign of wear.

The two blowers are driven through gearing from the rear of the engine, through friction clutches. Operation of the clutches is by means of remote hydraulic control which imposes very little effort on the pilot. The clutch servo controls are placed between the engine drive and the friction clutches. The first supercharger maintains atmospheric pressure and the power of the engine up to an altitude of 6500 feet; the second supercharger keeps up the good work to a height of 16,400 feet. The efficiency is so high—68 percent—that an inter-cooler is no longer necessary. When an altitude of about 13,000 feet is reached both impellers are made to work in series, and engine power is then fully maintained up to the extraordinary height of 29,500 feet. If stratosphere flying is to be attempted in real earnest, the two-stage supercharger will be an important element of success.—*A. K.*

Airports for Private Flying

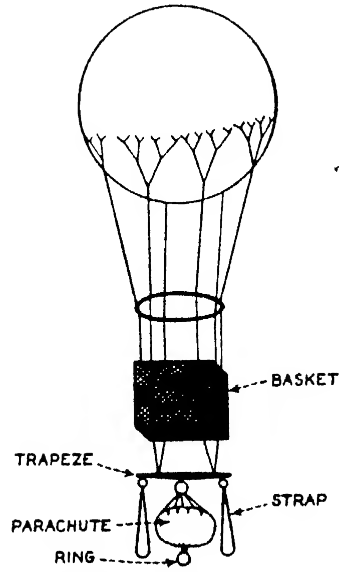
THERE are very definite reasons why private flying in the United States has progressed less rapidly than scheduled air transport. These are: doubts as to safety; the length of time and formalities required for flight instruction; the restricted number of flying fields; and last but not least, the cost. The Department of Commerce has made rather an ineffectual attempt to reduce cost of private airplanes by announcing a 700-dollar "flivver" airplane; in the matter of safety it has held a design competition and placed experimental orders for airplanes which it hopes will increase the safety and ease of operation.

Now the Department is attacking the airport situation by applying for 58,759,000 dollars from the Work Relief Funds, to be expended on airport improvements throughout the country. Part of this money is to be spent in "the preparation of airports for radio approach landings" in such cities as Newark, Pittsburgh, St. Louis, Kansas City, Indianapolis, Los Angeles, Seattle, and Washington. Other portions will be spent in the standardization and modernization of existing municipal airports, and in the construction of seaplane ramps in large centers.

From the point of view of the advancement of private flying, however, the most promising activity will be in the establishment of new airports in cities of 10,000 population or over, and in air marking on a national scale. The private flier needs more and more easily accessible landing fields, rather than the improvement of the great air transport terminals—however desirable this latter activity may be.—*A. K.*

A Record for Low Parachute Jumps

THE record low jump of 164 feet with a parachute is held by M. Réné Courtin, the French parachutist. M. Courtin uses a "flying trapeze" suspended below the basket



The equipment used in setting new record for low parachute jumps

of a balloon. He hangs on by two straps, with the parachute so arranged as to open almost instantaneously when he lets go. The diagram illustrates the method in schematic fashion.—*A. K.*

Self-Heating Food

CANNED food which heats itself when the can is opened is being used by Pan American Airways, according to *Food Industries*. Because of long-distance airplane flights, there has arisen a demand for food that can be eaten hot en route without operating a stove. This demand has been ingeniously met by the manufacture of self-heating canned food.

There is no magic about the heating

process. The can of food is encased in a second can which has one compartment containing unslaked lime and another filled with water. To heat the food, the chef merely turns the package upside down and punches holes through the lime and water compartments so that the water runs into the lime. Chemical action does the rest. There apparently is some porous filler material in the lime to retard and distribute the reaction, because it takes about half an hour for the food to heat.—*A. E. B.*

New Vitamin, Choline

A NEW vitamin which is essential for liver function, and which may play an important rôle in controlling diabetes, has been described by one of its discoverers, Dr. C. H. Best of Toronto, co-discoverer of insulin, the life-saving remedy for diabetes. The new vitamin has a real name, choline, instead of a letter as do most other members of the vitamin family. It is found in many foods, but the best sources are meat, egg yolk, and yeast.

Dr. M. Hershey and Miss M. E. Huntsman, of the University of Toronto, were responsible for many of the fundamental observations that led up to the discovery of the significance of choline.

Lack of this vitamin causes the serious condition of fatty liver, Dr. Best said. When the liver becomes fatty, it fails to make sugar or handle bile or do many of the things it should do, he explained. *Science Service.*

Telephone Set for Outdoor Use

FOR outdoor telephone service, such as is required by police and fire departments, at taxicab stations, and by watchmen, a new Western Electric telephone set is available. This set can be adapted to either manual or dial systems.

The new set has a cast aluminum hous-

New outdoor phone in use

ing divided by an inner door into a rear and front compartment. The switchhook projects through the upper part of this inner door and carries the handset, and a dial or apparatus blank is mounted near the center of the door. A spring catch holds the outer door shut when the set is not being used. The outer door may be opened by pulling the handle at the right of the set.

Within the rear compartment is the talking and signaling apparatus, consisting of an induction coil, a condenser, and the ringer, and provision is made for the installation of a relay when auxiliary signals are required. The gongs of the ringer extend through an opening in the bottom of the housing, which is provided with a removable cover with screened louvers to secure maximum audibility and at the same time provide protection against storms. When loud ringing telephone bells are used, a switch may be provided below and to the left of the dial, as shown in the illustration, to cut them in or out of the circuit as desired.

Model Planes Set New Records

A GASOLINE-powered model plane for outdoor flying stayed in the air for one hour, four minutes, and 12 seconds in the recent National Championship Model Airplane Meet held at St. Louis, Missouri, winning for Leo Weiss of New York City a subscription to Scientific American. This plane just missed setting a new record for its class by a few seconds, but new records were set by two other winners of subscriptions.

An indoor stick model rubber-powered plane, hand launched, flown by Carl Goldberg of Chicago, set an all-time record for indoor ships of any kind when it flew for 23 minutes, 29.3 seconds. An outdoor stick model rubber-powered plane, hand launched, by Richard Korda of Cleveland, flew for 24 minutes, 40.8 seconds to establish a new record for ships of its class.

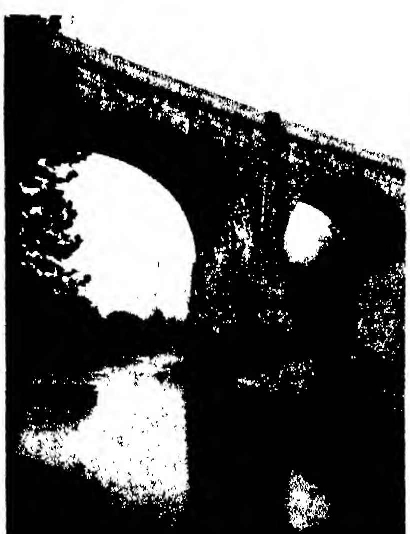
SUN ENERGY

A SCIENTIST has estimated that forest trees in the United States capture and store much more of the sun's radiation every year than is released by all the coal mined. Even at that there is a tremendous waste of the sun's energy, for the energy-utilizing process is wasteful in the extreme.

Patents on Activated Carbon Upheld

AT the height of the World War, a new weapon, poison gas, was suddenly unleashed on the Western Front. Immediately, every technical resource of the Allies was concentrated on the problem of devising some means of combating this new offensive weapon. It was Dr. N. K. Chaney, and his associates in the National Carbon Company, who discovered means of making activated carbon for use in gas masks, which provided effective defense against poison gas. Dr. Chaney was granted patents on his discoveries.

After the War, it was found that this highly activated carbon was equally efficient for a variety of peace-time uses. In 1919, the National Carbon Company began the manufacture of activated carbons by the Chaney process for industrial use. Other industrial concerns applied the same principles for the recovery of solvents by absorption in activated coconut carbon. So general was the peace-time application of Dr. Chaney's discovery that the National



They builded better than they knew! One hundred years ago, engineers built the stone arch viaduct shown in these photographs. It was designed to carry the early six-ton engines of the Baltimore and Ohio Railroad, but is still giving satisfactory service with 350-ton engines

Carbon Company finally brought suit for infringement of the Chaney patents against Richards and Company and the Zapon Company, of Stamford, Conn.

On May 13, in a decision rendered by the United States District Court for the District of Connecticut, the Chaney patents No. 1,497,543 and 1,497,544 were held valid and infringed. District Judge Hincks found the claims of the patents valid and rendered judgment in favor of the plaintiff for $24,410.65 on account of the infringement. —*A. E. B.*

Europe's Share of Motor Vehicles

COMPARED with the United States, where unique economic and transportation conditions have led to an unusual development in automotive traffic, the degree of motorization in Germany is still quite low. In Germany there is an average of one automobile to every 75 people, while the motorization quota in the United States is one automobile for every five inhabitants. The millionth automobile in Germany will be in operation this year; in the United States the first million mark was reached in 1913 and the second million mark was passed in 1915. There will be considerable possibility for further automotive expansion in Germany even after the level of France and Great Britain has been reached, for Europe is still in a relatively early stage of automotive development compared with the United States. For this reason the depression affected motorization differently in America than in Europe.

The steady rise in the use of automobiles in the United States was checked in 1930. As the depression became more severe from 1931 to 1933, the number of cars declined by nearly three million. In Europe, however, the long-run upward movement continued in spite of all the difficulties. In the first depression year (1930) the number of cars in Europe increased by 640,000 and in 1931 by 300,000. In 1932 there was a slight decline of 90,000 automobiles. But in the following year the upward movement set in again at the previous speed. By the end of 1933 there were 550,000 more cars in operation than at the end of 1932, and in 1934 there was a further increase of 500,000. As a result of this development, Europe's share of the world's motor vehicles has increased from 13.3 percent to 18.8 percent since 1929, whereas the share of the United States declined from 82.1 percent to 76.1 percent.—*Institut für Konjunkturforschung, Berlin.*

Leg Cramps

THE lame walk, through the workings of a glandular extract taken from the pancreas.

How this new medical miracle has been wrought on older persons, incapacitated by cramps of the leg muscles resulting from hardening of the arteries in the legs, was demonstrated by Drs. Irving S. Wright, A. W. Duryee, and co-workers of Bellevue and New York Postgraduate Hospitals, New York City, before the American and Canadian Medical Associations.

Men who could not attend their daily business because they were unable to walk as much as five city blocks without an attack of leg cramps were enabled by this treatment to walk as much as a mile and a

half. As a result they are able to keep on earning their livings.

The extract does not contain any of the insulin secreted by the pancreas. It does not cure the cramp condition, but relieves it. The injections are given three times a week and must be continued in order to keep up the relief.

Many persons who are going to chiropodists for treatment of cramps of the feet and legs are suffering from hardening of the arteries, although they do not realize that this condition is giving them the cramps.—*Science Service.*

Refrigerated Flies

IN the *Industrial Bulletin* of Arthur D. Little, Inc., consulting chemists, is reported the following story to illustrate an outstanding achievement in a field that is particularly dear to the chemist—the utilization of by-products.

"Although our own record in converting wastes and nuisances to profit is one upon which we pride ourselves, we gladly take off our hats to an industrial engineering friend of ours for a superlative achievement in this field which has just come to our notice.

"A client of his raised mushrooms and fertilized his beds with manure. This practice resulted in the hatching out of vast numbers of flies which were extremely difficult to get rid of.

"The engineer recommended the installation of a suction fan which passed both air and flies over some refrigerating coils in such manner as to chill the flies and then drop them in a dormant state into large cans. The installation was made and the flies eliminated as a nuisance.

"The canned flies are now shipped to frog raisers. Upon receipt the cans are immersed in a brine solution, which chills the flies and again renders them dormant. In that condition they are fed to the frogs.

"The mushroom grower now realizes from the sale of flies nearly as much as from the sale of mushrooms." *A. E. B.*

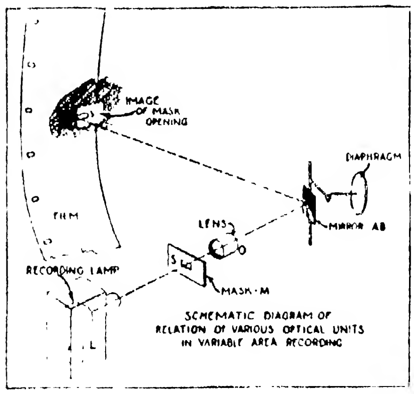
Home "Talkies" With New Sound Camera

SOUND-on-film, which revolutionized motion pictures in the theater, promises to do the same in the amateur and home movie field with the introduction of the first amateur sound camera with which anyone may now make his own "talkies."

The new sound camera utilizes film 16

millimeters wide with sprocket holes on one side only and a narrow track on the other side for recording the sound. Sixteen-millimeter sound projection equipment has been on the market for some time, but the new development of the RCA Manufacturing Company is the first amateur sound camera. In appearance and size it differs only slightly from the silent amateur movie camera, and though it incorporates a complete sound recording system, it weighs only 8¾ pounds fully loaded, including the three small flashlight cells for the recording light.

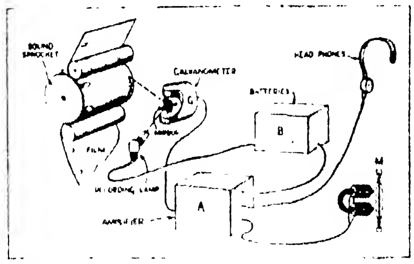
In operation, the photographer talks into a mouthpiece imbedded in the back of the camera as he focuses on the subject. Behind the mouthpiece a vibrating metal



diaphragm coupled mechanically to a tiny mirror is set in motion by the voice. A light beam directed on the mirror is reflected, with its fluctuations, on to the sensitized edge of the film as it passes through the camera. For recording outside sound effects as well as the persons being photographed, a separate microphone attachment together with electrical amplifying and recording equipment is provided for convenient mounting on a tripod, on which the camera is also placed. The total overall weight for this equipment is 20 pounds.

Amateur theatrical productions, amateur voice and screen tests, and more effective visual education are some of the more obvious possibilities which the new development opens up.

The new sound camera is already finding an interesting application in the work of Dr. Kurt Lewin, Professor of Child Psy-



Left: **Equipment set up for taking home talkies. Note the microphone overhead.** *Above:* **Schematic diagram of sound recording equipment**

chology at Cornell University. The recording microphone and camera are concealed behind familiar objects in a room so that the subjects do not know they are being observed, and a sound motion picture record is made of children's reactions to commands, suggestions, and other stimuli, to be studied later by interested psychologists.

Above: **The self-contained sound camera with mechanical microphone.** *Left:* **How the mechanical microphone records sound on film**

The Department of Interior is using one of the new cameras to make records of the soil erosion which is ruining so much pasture land in the West, with the investigator making his comments on the actual locations, permitting him to point out the preventative methods which may be applied.

In the United States Coast Guard Service too, tests have been carried on with the new camera. Sound picture records have been made of the scene where assistance was rendered to vessels at sea. Thus the observing officer was able to record a running account of the circumstances while they were actually taking place and being photographed, instead of relying entirely on memory to retain the essential data. Other possibilities of use are offered in crime detection where the testimony of prisoners and important witnesses may be taken on the scene of a crime.

WALL CLEANER

A FRENCH patent gives a composition of 455 parts of corn flour, 40 parts of copper sulfate, and 5 parts of alum, mixed with boiling water, for use in cleaning walls, paint, and so on.—*A. E. B.*

Now You Can Eat Garlic!

YOUR best friend *can* now tell you! A lasting remedy for offensive breath odors seems at hand. Even the long-lingering odor of garlic yields to treatment devised by Drs. Howard W. Haggard and Leon H. Greenberg, of Yale's laboratory of applied physiology. Reporting in the *Journal of the American Medical Association*, the Yale physicians state: "The breath can be immediately and completely rid of the odor (garlic) by washing the teeth and tongue and rinsing the mouth with a solution of chloramine. The chlorine liberated in the mouth reacts chemically with the essential oils and deodorizes them. It is probable that many cases of foul breath from other causes would be amenable to the same method of treatment."

The solution of chloramine was made by

dissolving one 4.6-grain tablet in a small amount of water. Chloramine is a well-known chemical, available at drugstores, which is used in the treatment of wounds and for sterilizing drinking water.

In the Yale treatment particular attention was paid to the brushing of the tongue, for the papillae at the base of the tongue have long been under suspicion as the source of odor from retained food particles.

In their experiments Drs. Haggard and Greenberg first proved that the source of most obnoxious breath is not systematic but local. It arises, at least in the case of onions and garlic, solely from particles retained in and about the structures of the mouth. Air in the lungs does not taint the blood; the stomach is not at fault, nor is the saliva.

Having determined this, the physicians set about either to remove or deodorize the particles. They brushed the teeth and tongues of their subjects with soap and water and rinsed their mouths. Still the odor remained. Next they tried the proprietary mouth washes which rely on alcohol to sweeten the breath. These only masked the odor for from 15 to 20 minutes. Finally they hit upon the chloramine solution treatment, which brings lasting relief when used in connection with thorough brushing. *Science Service.*

Flowers "Heavenly" To Some, Objectionable To Others

ARE freesias fragrant? Before you select this flower as a sweet messenger to send to a lady, better find out what she thinks about it. Surprising differences in the smell of this flower to different individuals have been reported to the Eugenics Research Association.

At the recent flower show in New York, Dr. Albert F. Blakeslee, of the Carnegie Institution of Washington, secured 16,800 votes on the smell of different varieties of freesias. The same flower that one woman pronounced as "heavenly" was exclaimed over in anger by the man who followed her in the line. "Why, lady, they're terrible!" he said. Another flower that she had thought must have been doctored to remove the smell had a strong fragrance to the man.

Whether you find the odor of a flower lovely or not depends on several individual matters. For one reason or another, individuals may lose their sensitiveness to odors. A cold will sometimes be blamed, or sinus trouble. Some few seem to inherit a tendency to lose all sense of smell. Some are born with very dull smelling ability. And those who are keen to detect one odor may not notice another at all.—*Science Service.*

New Plant Doubles Bromine Production

SOME months ago we reported, in these columns, the opening of a new plant at Wilmington, North Carolina, erected for the purpose of extracting bromine from sea water. It is interesting to observe the effect of this new venture on the country's total bromine production in 1934, as revealed by government statistics just released. United States production of bromine in 1934 amounted to 15,344,290 pounds valued at 3,227,425 dollars, an increase of

(*Please turn to page* 157)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

MAKING a telescope in a big city, where supplies and kindred spirits are to be found, is one thing; making one alone, in a small village or on a farm, may be another; but here is a letter from a man who made one in the very back of beyond, at Bambur, Nigeria. Ira E. McBride is the man. Read this: "One of the main requirements was patience. Return mail from America takes four months, so I waited that long for the book 'Amateur Telescope Making,' after sending to you for it. Then I waited four months more after sending for the mirror materials. Twice while silvering I had to send to the Coast, a thousand miles and a two months' wait. I claim," he asserts, and we second the motion, "that these waits are enough to try any amateur's enthusiasm. Well," he continues, "here's a picture to show that patience was at last rewarded. The natives called the telescope the '*gigabgipasina*,' that is, the thing-for-seeing-things-far-away. They had had many theories among them about the dark spots and light spots on the moon, but all was settled when they looked through the telescope: 'Mountains—just like ours.' And Saturn—'He wears a belt, just as we do.' (Popular styles in the Wurkum tribe demand at least a belt.)" And now McBride has visited home (Kansas) and gone back again to Nigeria (Bambur, via Jos and Lan, Nigeria, B. W. Africa) with the materials for making a 12-inch.

McBride and the gigabgipasina

"THE fork is weak, and I have learned what tremors are." This is G. O. Bjordal, Box 111, Askim, Ostfold, Norway, and he made his first telescope from the instructions in Krudy-Brunn's "*Das Moderne Spiegelteleskop in der Astronomie.*" This German instruction book lacks the typical German thoroughness, telling how to make a mirror but not telling how to use r^2/R. "I ask every new beginning amateur," Bjordal now urges, "to make the fork in the mounting so rigid that it can carry a big dog without any bending." Bjordal discovered that his first mirror was very much over-corrected, but on getting hold of a copy of "Amateur Telescope Making," made, not in Germany but in the U. S. A., he says he made a new and fine mirror. He uses his telescope throughout the long winter nights of Norway—15 to 20 hours.

IN contrast with the mounting whose weakness its owner points out, look at one by H. I. Linn, 2737 Humboldt Ave., Oakland, Calif., made for a 6" mirror. "There is no machine work on it whatever," Linn writes, "except to drill and tap for a set-screw in the unions, to hold them in position. There are two types of unions—gasket and ground, and the ground joint should be used, as the other has side play." The stocky saddle of this mounting is a steam-pipe saddle. The pipe fittings are all standard 3½-inch: for declination axis, one cap, one long nip, one union, one T, one butt nip (inside), one pipe saddle; for polar axis, one union, one butt nip (inside), one 45° el; for post, one nip, one flange. (Add wedge under flange to correct for latitude.) Here is a mounting that will not shiver, for it has plenty of metal at the neck—that place on the declination-axis shaft, between the tube and polar-axis shaft, where so many declination axes are thin swan's necks instead of bull necks. Linn's is one of the best—cleanest and steadiest—small mountings we have seen.

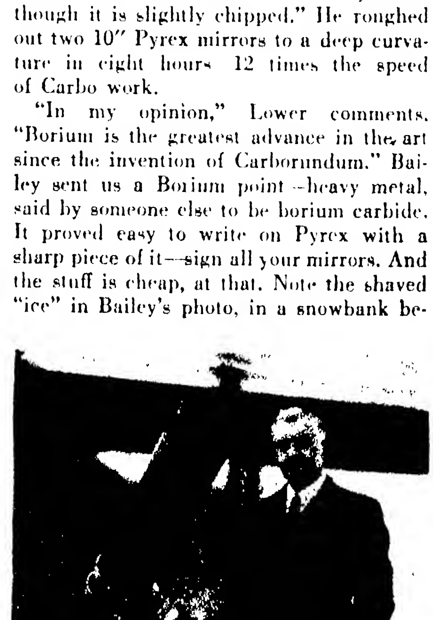
Bjordal of Norway

IN "A.T.M.," page 375, there is a photograph of a 6-inch, made by W. F. Sprengnether, Jr., and its "neat, finished workmanship" is mentioned in the legend beneath the picture. The same Sprengnether now sends us a photograph of another job he has done, and this again looks like professional instrument-maker's work. He doesn't say anything about it, but the picture speaks for itself.

HOGGING out the concavity on the average telescope mirror is too brief a job—only a few hours—to warrant setting up special equipment for short cuts, but on larger jobs, or on small mirrors having very deep curves, any practicable short cuts are worth looking into. It took Harold Lower of San Diego, plus a grinding machine, 98 hours, and used up all the Carbo west of the Rocky Mountains (25 pounds), to rough out the deep curve on his $f/1$ Schmidt mirror—the "Soup Bowl"—shown on page 295 of the June number. This curve is over an inch in depth. (Incidentally, Lower says such a curve involves literally *figuring* with Carbo—so closely must it be worked before polishing is even begun.)

Just after Lower had done all that work, something new and better turned up—Borium. Here is the dope on Borium: The Stoody Company, it seems, located in Whittier, California, supplies Borium lathe tools, and with these you turn your curve in the glass just as you would turn a disk of metal. A piece of Borium ½" x ⅝" is used, and the glass is pitched to the face plate. Note picture on p. 156, sent by Dr. H. Page Bailey of Riverside, California. Concerning it he writes, "It is a revelation to see the glass scrape off just like scraping ice with a steel tool. The tool I used on two 10" Pyrex disks doesn't even show any wear, though it is slightly chipped." He roughed out two 10" Pyrex mirrors to a deep curvature in eight hours—12 times the speed of Carbo work.

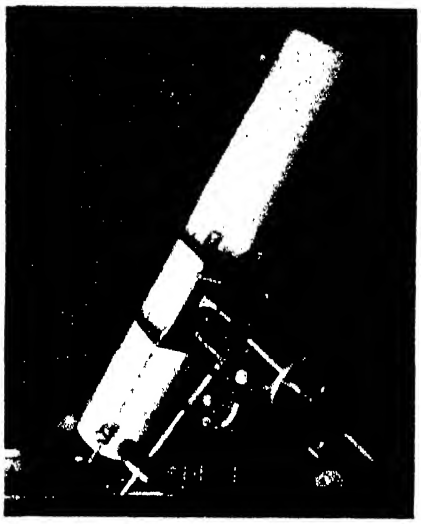
"In my opinion," Lower comments, "Borium is the greatest advance in the art since the invention of Carborundum." Bailey sent us a Borium point—heavy metal, said by someone else to be borium carbide. It proved easy to write on Pyrex with a sharp piece of it—sign all your mirrors. And the stuff is cheap, at that. Note the shaved "ice" in Bailey's photo, in a snowbank be-



Linn and Gibraltar

neath the tool. The metal is shattered in a vise, a selected point is brazed, welded or silver-soldered into a saw cut in the end of a drill rod, and dressed to a broad angle on a Carborundum stone.

HERE is another way of roughing out—a machine which J. H. Hindle of England invented and has been using on a 30-inch he is now making. The picture is



Sprengnether's No. 2—smooth

almost self-explanatory: rotating horizontal metal mandrel or "torpedo;" slowly rotating chuck for disk on vertical shaft, rope pulley, at bottom; capstan (note handles) for jacking it gradually upward.

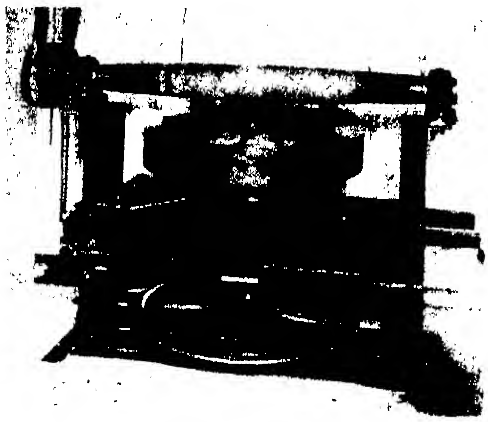
"I find this machine works excellently in practice," Hindle writes, "the concavity of the disk retains the water and grinding material, and a great advantage is that, if the disk is first ground on the back, this machine finishes it equal thickness all over. But do not," he continues, "run away with the idea that this machine will finish-grind it; the fine grinding has to be done in the ordinary way." Mr. Hindle, after making the 20-inch shown on page 453 of "A.T.M.," has now tackled a 30-inch job. Fine grinding is being done on another machine of his invention (to be shown later) and figuring is done face up with small hand tools, while the mirror is resting on the 18-point flotation system for the telescope.

HERE is an idea for those who like to organize organizations: Let's get up a sort of female relief auxiliary to this hobby, not for the purpose of encouraging "female" telescopes, but to assist us noble male telescope makers. For example, the ladies could spoon feed us while we grind, as Caroline Herschel did her brother, sing to us, even kiss us, and make lots of other noble sacrifices to science. Mrs. Scribe was the first to be invited to join this inspired, humanitarian movement, but ungratefully countered with the proposal to organize, instead, and on a militant suffrage basis at that, "The American Association of Optics Widows." Plank No. 1 in the platform of her organization would be for these suffragettes to fill up all cellars with earth, so that husbands, coming up for air, could not get back to their subterranean optical shops.

"I thought," writes one TN, "that I was the only one who had any differences of opinion with his better half as to the

value of telescope building. Mine declares she is a 'telescope widow' and that I don't love her any more." Other wives seem to object unreasonably to finding rouge, not alone on shirts, but on table and bed linen, and pitch on the furniture and rugs.

Mrs. Scribe now threatens to organize all these uncoördinated rumblings into a vast feminist movement which will put all TNs back into the exact, rather than the approximate, buzzms of their families. This forces us to reveal our real, original, secret motive in starting this whole telescope making movement, nine years ago. It was not to aid science but to keep 10,000 of you fellows at home and far, far from the old Demon Rum and ultimate Hell-fire. This will give your scribe something to claim some day, when standing before St. Peter, to offset some other things that need offsetting. In the meantime, truly appreciative wives really should send him fudge, for at least keeping their husbands away from platinum blondes, even if they do dive down cellar for most of the night.



Hindle's torpedo excavator

IT gets hot in Atlanta. J. J. Stoy, 501 City Hall, Atlanta, Ga., says so, but since this question is not in itself an essential part of our argument, we simply refer it to the Atlanta Chamber of Commerce, with recommendations of mercy to Stoy, who surely meant well. The point is that Stoy has been using, and liking, a new kind of tropical (this gets worse) lap. He says, "The Barbour Asphalt Co., 30 Arch St., Philadelphia, Pa., processes a pure Trinidad bitumen, designated as 'G-O,' that works well in a hot climate when treated with a half teaspoonful of turps to the quarter inch thick lap for 6" mirror and about 8 percent by volume (not weight) of beeswax. It comes in 5-pound pails. Even after use of 20 pounds weight for cold pressing for 24 hours, with temperatures ranging between 75° and 85°, no material slumping is visible. After 12 hours of polishing, the channels only require further deepening once, and it does not scratch, as would be expected. Figure shapes up beautifully and normally with 30 minutes' work, then 15 minutes' cold pressing with 25 pounds weight. Mirror *always* works smoothly. Variations of as much as 15° do not seem to bother the figure in any way."

Stoy's letter was sent to Harold Lower in San Diego, for an opinion from southern latitudes, and his reply was that it never gets that hot in San Diego, and that San Diego, by golly, is *not* in the tropics! Well —try it out, somebody.

STOY had another good idea: To forestall bubbles in pitch laps, melt the pitch in a pot having the emphasis on area and not on depth. Deep pots, and deep pitch in them, trap the bubbles. We tried this out and it worked fine. This subject introduces a letter from Edward P. Goodell, 5528 Wayne Ave., Germantown, Pa., who says that memories of old days when, as a boy, he dipped bayberry candles, came back to him, so he dips or dunks his laps. "Why not dip the tool?" he writes, and then goes on to say: "I spread a little turpentine over its face and, grasping it by its handle, carefully lower it into the pitch until the face is half the tool's thickness below the surface. I then raise it and, holding its face in a vertical position, slowly twist it back and forth for a few seconds to prevent dropping, and then lay it face up, on the table. If, after forming the surface with a soapy mirror, I find that the pitch coating is too thin, it is a simple matter to repeat the process to obtain the correct thickness. I use Pierce's method of making channels, pressing them into the surface by means of a soaped steel scale. The result is the smoothest lap I've ever laid eyes on, absolutely free from bubbles and from the chipped-out places which I so often got when trying to cut my channels. Incidentally, this method makes it an easy matter to form laps on tools without raising them far above room temperature, so that polishing may begin only half an hour after dipping."

Joseph A. McCarroll, 521 Palisade Ave., Teaneck, N. J., the coal-tar pitch man (who, by the way, will try to handle orders for coal-tar pitch with different, known melting points for controllable hardness) says he makes his channels thus: A thin stick is shaved to the shape of a crude knife, wetted, pressed in and tipped to either side. After a little practice with the tipping technique the facets made are not irregularly wrinkled but round up clear across, the bulge on one side meeting the bulge on the other, blending with it, and giving the lap an effect like a pan of round baking-powder biscuits just out of the oven. No need to press these down: just go to work on the apices of the biscuits and they will gradually come down as you work.

EVERY little while someone discovers independently that if the knife-edge in the shadow test is brought in from the other direction, the pinhole remaining as before, the shadows will be reversed—thus a paraboloidal shadow becomes an oblate. This idea was first reported to us by the late J. C. Critchett of Julian, Calif., in October, 1932, and its use may help in mentally delimiting the areas of light and shadow. Mr. Critchett used a double knife-edge, like a broad slit (really two opposed knife-edges), letting the rays come between the sides but using only one side at a time. This set-up facilitates quickly choosing either side, in order to get either reversal. With the reversal a turned-down edge becomes a turned-up edge, or vice versa. Hills become holes, and raised zones become depressed zones. It's fun.

FURTHER with regard to answering other amateurs' letters in pencil, informally, on the margins and backs, mentioned a month ago: Making it easy for the correspondent is not the only point in favor of this method, for it puts the answers opposite the questions asked, thus giving a closely tied-up record. It is not a job, but fun, to do it in that way—say when riding on a train or leisurely reclining on a soft sofa at home, but if the letter must be answered formally it is less likely to be answered so carefully, because it must then be re-read at the time the answer is dictated or written. The other way really amounts to an informal, natural conversation between friendly addicts of the same incurable habit.

Your scribe often starts reading a letter, sees it is from a telescope maker, says to himself, "That's too good to try to read in this busy place," and throws it down beside his hat, to be picked up and read at leisure on the long way home, where it can be enjoyed and studied in peace. The answers that then come to mind as it is read, and are jotted down in the margins, would not come again to mind so readily or spontaneously a couple of days afterward, if it were included in the regular grist of a million less interesting letters to be answered—less interesting because not about amateur optics. The informal, with-pencil-on-the-back style of answering fellow telescope makers' notes was set by Porter, years ago. If you get a reply of that sort, don't think you are being discriminated against: we'd answer Napoleon in the same way.

EVIDENTLY a lot of people have been making good mirrors, adding bad prisms and eyepieces to them, then wondering what can be the matter. A letter from H. E. Dall, of England, bears on this point: "Out of hundreds of prisms I have tested, only a small proportion are sufficiently good not to give a perceptible error on the final image. Some 1½" (name of a noted maker.—*Ed.*) I have seen ruined the image of a good $f/7$ mirror. When three surfaces are concerned, it is obvious that first quality extra is wanted." If your mirror is good, use a good prism.

A certain amateur in California has been using his telescope to watch a doctor kissing his nurse, in a building 1.7 miles away. Readers, want the story? Shall we snitch on him?

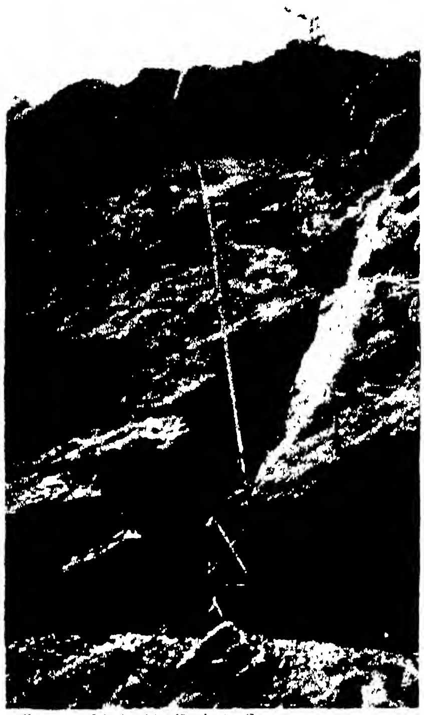
Peeling off Pyrex on a lathe

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 153)

51 percent in quantity and 58 percent in value over 1933. Bromine is used principally in the form of ethylene dibromide for the manufacture of anti-knock gasoline.

Imports of ethylene dibromide in 1934 amounted to 649,987 pounds valued at 143,164 dollars, compared with 290,410 pounds valued at 55,864 dollars imported in 1933. Imports of potassium bromide in 1934 amounted to 4410 pounds valued at 1047 dollars; in 1933, 9921 pounds valued at 1813 dollars. No raw bromine was imported in 1933 or 1934, and only small quantities of other salts.—*A. E. B.*



Courtesy Linde Air Products Company

A welded pipe line solved a problem of transporting dry cement down a steep grade to the mixing plant of an engineering project. At one point there was a drop of over a thousand feet. The smooth welded joints made it possible for this gravity system to function properly

New Ships Have Boilers on Deck

BOILERS on deck, instead of in the conventional position in the hold, characterize two new Norwegian coal-burning freight ships recently put into service on an African route.

While the main idea was to gain more cargo space in the hold, several other advantages have developed. The "black crew" is delivered from the infernal heat of the ordinary stokehold in the tropics. Unloading ashes is no longer a problem: a slanting pipe simply discharges them into the sea as fast as they are raked out. Getting the boilers away from the bottom of the ship has done away with the rapid rusting of

the bottom plates, always a troublesome factor in steamship operation.

Finally, officers declare that the ships behave much better in a rough sea, even when running empty or only partly laden, than do ships of like tonnage with the boiler weight far down on the keel. —*Science Service.*

Ten-Minute Soil Analyzer

ECONOMIES in time that will result in increased yields through proper fertilization of agricultural fields, are made possible through a new soil analysis device originated in Honolulu. By it laborious chemical tests that normally require weeks to complete are replaced by a method requiring but a few minutes. As a result, complete plotting of the required fertilization of every part of a field can be secured while time is still available to make use of the information for the benefit of the then growing crop. Spotted fields will be eliminated; average yields will be increased; and the whole will be accomplished at an infinitely decreased laboratory cost.

The apparatus for analyzing soils does in seven to ten minutes what formerly required five weeks. It is the development of chemists at the experiment station of the Hawaiian Sugar Planters' Association. Hamilton P. Agee, station director, has recently announced its successful tests.

This development, which may be described as revolutionizing methods of testing soils, is the fruit of two years of study and experimentation by personnel of the department headed by Francis E. Hance. Beginning with the crude soil-testing "kits" used by farmers elsewhere in the United States, experiment station chemists have worked out devices which combine the speed of those rudimentary indicators with the accuracy of a laboratory analysis.

The result is nothing less than a precision machine, which is now in use on all planta-

Essential features of the 10-minute soil analyzing equipment. The illuminated window is in the lid

tions in the territory which maintain agriculturists.

The "analytical assembly," as it is called, or rather the assemblies, for there are nine of them for various analytical purposes, resembles, when closed, a box about 15 inches square and perhaps two feet high.

A small sample—one cubic centimeter, to be exact—of soil is agitated for half a minute with what chemists call "a weakly acidulous aqueous solution," that is, water containing a little acid. This is immediately filtered. The filtrate—the material that passes through the filter—contains the readily soluble soil materials. Portions of this filtrate are taken for individual analyses. Two reagents are added, and the mixture is placed for half a minute on the mechanical rotating device, which in addition to moving round and round, has a slight swaying motion suggestive of the hula. This produces "turbidity," a muddiness of the liquid, which is proportional to the amount

The rotating part of the soil analyzer is in a shelf directly below the cabinet containing the light source

of potash, for example, or other element for which the test is being made, in the soil. The amount of that turbidity is measured on an illuminated series of lines of different degrees of density and blackness. From the reading of these, the operator can refer to a previously prepared chart and determine the percentage or pounds per acre of the element for which the analysis is being made. All this is done in less than ten minutes.

These assemblies are now in use almost universally on HSPA plantations, and the results are checked with the laboratory at the experiment station. In connection with other studies, results of which are correlated—as, for example, growing an "indicator" plant in the same soil—they enable the planter to practice more intelligent fertilization. They can be used for determining the content of certain chemical elements in cane juice as well as in soil.

There are assemblies for potash, phosphate, and phosphate fixation in soil; for potash and for phosphate in cane; for reaction—acid, neutral, or alkaline; for available nitrogen, and for the total amount of nitrogen in cane juice or other material.

Chemical Research Produces Better Gasoline

IMPROVEMENTS in the manufacture of gasoline during the past ten years have revolutionized automobile engine design. As the chemist has discovered what really constitutes good gasoline, he has been able to modify the procedure in refining crude oil so as to produce a motor fuel that is satisfactory in engines of much higher compression ratio than formerly. Whereas the average compression ratio in passenger cars ten years ago was about 4.4, in the 1935 cars it is about 6.0.

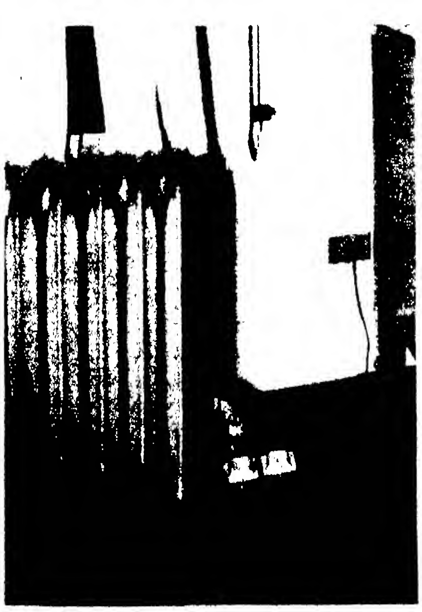
J. Bennett Hill of the Sun Oil Company explained how this improvement has been accomplished by petroleum chemists at a recent meeting of the American Chemical Society in New York City. The most important factors, said Mr. Hill, are (1) a control of cracking conditions in making the gasoline so as to give maximum octane rating and (2) the development of the tetra-ethyl lead which is added to gasoline to suppress knocking.

The question of proper gasoline volatility has been difficult, since inherently easy-starting characteristics and freedom from "vapor lock" are opposed to one another. Easy starting in cold weather requires a certain amount of easily vaporizable material in the gasoline; on the other hand, these volatile hydrocarbons tend to cause "vapor-lock"—that is, vaporization in the intake system of the car and consequent upsetting of the proper metering to the carbureter and irregular operation or stopping of the engine. This situation has been improved by sharply eliminating from gasoline the extremely volatile hydrocarbons, such as ethane and propane, since these compounds cause vapor-locking difficulty out of all proportion to their value in making starting easier. Even with an ideal gasoline it was impossible, however, some years ago to obtain in some cars easy starting on the cold days of a month and freedom from vapor lock on the warm days. This condition is subject to improvement by proper design of the automobile, and some automobile manufacturers have now taken steps in this direction.—*A.E.B.*

Phantom Alarm Foils Intruders

WINDOWS in the private home may now be adequately protected from intruders by means of the phantom Faratron cell. It is not necessary for the intending intruder even to touch the window screen: his approach will start the Faratron in operation.

An advantage of this phantom cell is that it operates without light rays or other visible means of control. It is an adaptation of the radio oscillator and so can be built and installed by anyone familiar with these types of circuits.



The phantom alarm, using an oscillator circuit, takes up little space

In the photo-electric cell—as mysterious as is its action—there must be the beam of light, the breaking of which operates a relay switch, thus opening or closing the main electric circuit. In the phantom Faratron cell, however, merely the presence or the nearness of a person or object will do the same work.

This new electronic cell opens up as interesting a world of experiment for the electrical enthusiast as did the radio receiving set of ten years ago.

UBIQUITOUS ALUMINUM

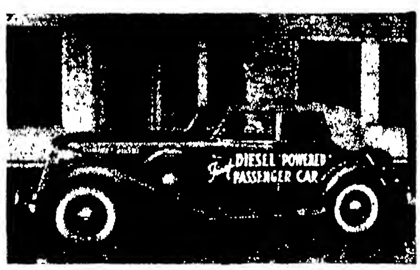
ALUMINUM is one of the most ubiquitous of metals. It is used in electric ironers to conduct heat; aluminum foil is used in refrigerator installations to prevent the flow of heat.—*A. E. B.*

Fuel for Coast-to-Coast Diesel Car=$7.63

AN Auburn car powered with a Cummins Diesel engine arrived in Los Angeles recently after covering the 3774 miles between New York and Los Angeles at a cost of $7.63 for fuel.

An average of 34.62 miles per gallon of fuel oil was made for the total trip.

The $7.63 fuel cost was approximately one seventh of what the cost for gasoline would have been in an ordinary automobile. C. L. Cummins, president of the Cummins Engine Company, and owner of the car, said on his arrival.



No changes were made in this car body in adapting it to a Diesel

Mr. Cummins purchased a new car recently and replaced its regular gasoline engine with the automobile Diesel engine to make this test run. This Diesel engine is an experimental motor and is said to be the first passenger car Diesel engine ever placed in actual operation on the highway.

The engine manufacturer said that he had experienced no trouble in any way and that the car had performed in an excellent manner throughout the trip. No effort was made to take the shortest route or to set a speed record, the Diesel-powered car being held at an average speed of approximately 50 miles an hour. However, speeds of 75 miles an hour were often attained. Top speed of the car is 90 miles an hour.

The significance of this transcontinental economy trip is far reaching, because it demonstrates the flexibility, acceleration, light weight, freedom from smoke, and dependability of Diesel engines as applied to motor cars. It has a distinct bearing on the

The cross-country Diesel engine installed in a standard automobile chassis

marine, stationary, light truck, and general industrial fields. This power unit will be used in all of these fields and will be in regular production for other than automotive service during the next two to three months.

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700 METEORITES

Strange, you say, that so few meteorites seen to fall are afterwards found. In the Field Museum of Natural History, however, 52 percent of their collection of more than 700 meteorites were actually seen to fall.

Corrosion-Resisting Paint

The binder used in "Acidseal," a new line of corrosion-resisting paints, is a rubber compound, hard and flexible, which gives the paint practically the same resistance as crude rubber. Acids and alkalies are said to have no effect, with the exception of those of an oxidizing character such as nitric acid or sodium hypochlorite. The paints are recommended wherever corrosive conditions exist but not for exposure to direct sunlight. They are handled much like lacquers by brushing, spraying, or dipping. They are said to adhere well to all surfaces and are available in a wide range of practical colors.—*A. E. B.*

Acne-Sufferers Should Avoid Spinach, Pork, Potatoes

Persons suffering with acne would do well to avoid spinach, pork, potatoes, it appears from a report by Drs. T. D. Cunningham and J. C. Mendenhall, of Denver. These foods more than any others caused a reaction in acne sufferers who were tested for food sensitivity, the Denver physicians found from skin tests similar to those made on hay fever and asthma patients. The tests were made in the course of a search for the cause of acne.

This troublesome condition, one form of which is the familiar "breaking out" seen on the skins of adolescents, is apparently a state of sensitiveness to foods. Practically all acne sufferers are sensitive to proteins in foods, Drs. Cunningham and Mendenhall reported. Other factors such as drugs and glandular disturbances can and do produce acne in a small group of cases.

Diet has long been a method of treating acne, but the work of the Denver physicians shows that the diet can now be put on a more exact and scientific basis. Instead of avoiding certain general classes of foods, as formerly, the acne sufferer can now have the skin tests made to determine whether food is the cause of his condition and if so which foods in particular he should avoid. Half of the acne sufferers described said they had from 90 to 100 percent relief after following a diet selected in this way. The majority of the patients, 75 percent, received from 50 to 100 percent relief by avoiding the foods to which they were found sensitive.—*Science Service.*

Inside the Stratosphere Balloon Gondola

The gondola of the National Geographic Society-Army Air Corps balloon *Explorer II* is packed with scientific apparatus. Unfortunately, the fabric of the balloon ripped while being inflated for its scheduled flight in July from near Rapid City, South Dakota, but it is thought that the flight may still be made before the end of the year. In the accompanying illustration showing the interior of the gondola, which of

In the stratosphere balloon gondola

course, was unharmed, are Capt. Albert Stevens, right, and Capt. Orvil Anderson testing the compactly-arranged apparatus. Identifying numbers for the various instruments have been obtained by *Science Service* in co-operation with the National Geographic Society. They are:

1. Altimeter.
2. Lead-shielded electroscope for detecting cosmic rays.
3. Electrical firing device for releasing ballast from bags hung outside gondola.
4. Cylinders of compressed gas for operating balloon valves.
5. Cosmic ray instrument.
6. Container for stratosphere air.
7. Part of air-conditioning unit.
8. Battery of factograph cameras for recording readings of 19 instrument dials.
9. Aerial camera for photographing horizon.

CURRENT BULLETIN BRIEFS

THIS THING CALLED AIR CONDITIONING. Exactly what air conditioning is, the six vital factors rendering air conditioning desirable, a brief description of different types of equipment, and how to proceed with the installation of such equipment—all these things are summarized within the 32 pages of this well printed brochure. Request this bulletin on your business letterhead. *Minneapolis-Honeywell Regulator Company, 2927 Fourth Avenue South, Minneapolis, Minn.*

CRAFT WITH "CELLOPHANE". A 32-page booklet packed with directions and illustrations detailing how to make 101 separate items from Cellophane, including belts, bracelets, lamp shades, book jackets, crocheted hats, and so on. *Write for Bulletin 935A to Scientific American, 24 West 40 Street, New York City.—10 cents.*

AN OPEN LETTER to E. J. Mehren, President, Portland Cement Association, from J. E. Pennybacker, Managing Director, The Asphalt Institute, is put out in pamphlet form in an attempt to clarify certain phases of the cost of road construction. *The Asphalt Institute, 601 Second Avenue, New York City.—Gratis.*

STAINLESS STEELS TREATED WITH COLUMBIUM is the title of a four-page pamphlet which shows how the addition of columbium to certain types of stainless steel results in the elimination of intergranular corrosion. Three tables give the results of a series of tests. *Write for Bulletin 935C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

QUAIL-FOOD PLANTS OF THE SOUTHEASTERN STATES, by Alec C. Martin, lists 46 food preferences of quail and gives splendid descriptions and comments regarding each one. Illustrations show many of the plants. Circular 348, United States Department of Agriculture. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

INDICATING AND RECORDING GAGES is a compilation of various types of gages used in industrial operations. A series of excellent illustrations and accompanying descriptions show how the gages work. They are particularly applicable to the indication, control, and recording of drafts in furnace and boiler installations and also to air filtration and refrigeration plants. *Write for Bulletin 935B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

WHAT THE MEDIA OWNER NEEDS AND THE ADVERTISING AGENCY DOES is a little heart to heart talk between an advertising agency and the executive in a business which requires the help of such an agency. It deals particularly with the relationship of publishers to advertising and the advertising agency. *American Association of Advertising Agencies, 420 Lexington Avenue, New York City.—Gratis.*

WHAT TO READ ABOUT MEXICO is a compact little 48-page booklet listing dozens of books dealing with Mexico history, customs, people, politics and so on. Both English and Spanish books are listed. *Write for Bulletin 935D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

THE ELECTRIC EYE IN THEORY AND PRACTICE is a 32-page booklet setting forth the various industrial uses of photo-electric cells in a wide variety of work. Illustrated with 30 diagrams. This bulletin is sent gratis to electrical and industrial executives requesting it on company stationery. To all others it is priced at 50 cents. *Hugh H. Eby, Inc., 2066 Hunting Park Avenue, Philadelphia, Pa.*

TWELVE RULES FOR TIRE HEALTH, by K. D. Smith, is a four-page pamphlet listing in clear and concise form the various troubles to which automobile tires are subject, and how many of them can be avoided. *Write for Bulletin 935E to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

SWIFT & COMPANY 50TH ANNIVERSARY YEAR BOOK is a beautiful piece of literature describing the progress of a large meat packing company over half a century and covering more specifically activities for the year 1934. Well illustrated, including four unusual color plates. *Swift & Company, Public Relations Department, Union Stock Yards, Chicago, Illinois.—Gratis.*

MATHEMATICS OF RADIO SERVICING, by M. N. Beitman, is a mimeographed booklet of value to men engaged in radio service work who have a slight working knowledge of arithmetic and elementary algebra, and who realize that this knowledge can be made a definite asset in their work. *Write for Bulletin 935F to Scientific American, 24 West 40th Street, New York City.—50 cents.*

WHITHER PUBLIC RELATIONS WORK? is a dispassionate survey of the art of publicity. It surveys the history of public relations and treats in some detail the present methods and trends. *Distributed gratis to specialists in industrial management and in professional, trade and public relations activities by Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.*

CAMERA ANGLES

Conducted by JACOB DESCHIN

Portraits with Photofloods

With two large lights and a smaller one for backlighting, an amateur equipped with the simplest of folding cameras can sometimes equal the work of an experienced professional, provided he is willing to follow some simple precautions, such as those put forth in the following paragraphs.

The most convenient and least expensive source of light for the non-professional is the Photoflood bulb. Used in reflectors, two of these bulbs will, with a balancing

A well-lighted portrait

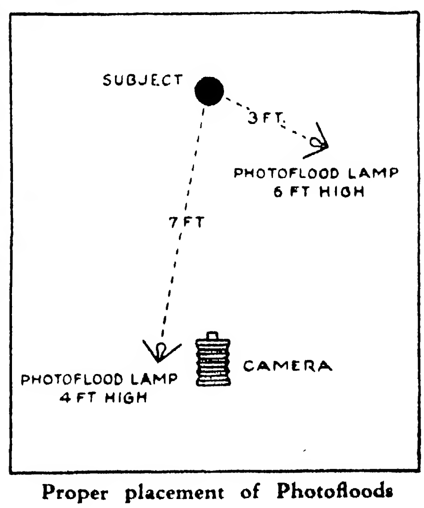
light unit for the highlight side of the face, permit snapshot exposures indoors or at night.

While the ideal camera for portraiture is one having a double or triple extension bellows, a ground glass for focusing and designed to take lenses of different focal lengths as desired, an amateur with a simple folding camera can get good close-ups by using a portrait attachment. If your camera does not have a lens of a focal length at least equal to the diagonal of the film used, do not attempt to get too near your subject in order to get a large "head and shoulders" portrait. Bad perspective and distortion will result. Seven or eight feet is the nearest you should get to your subject and if at this distance you feel you are including more than you want, the enlarging camera in the dark room will give you what your lens balked at.

Avoid darkroom heartbreaks by careful focusing on the ground glass or, in the case of a focusing-by-scale camera, by carefully measuring the distance from subject to camera and then setting the scale accordingly; by always mounting the camera on a steady tripod; and by using panchromatic films. This type of film, being sensitive to all colors, including red, almost eliminates freckles and other skin blemishes in the final printing of the negative. Panchromatic film, incidentally, should be developed in total darkness according to the manufacturer's directions.

It is proper lighting that makes the picture. A good portrait should have delicate halftones, transparency in the shadows, and details in the highlights. Modeling of the face is done with the highlighting unit, which should be raised to a height of six or seven feet and pointed down at the subject at a 45-degree angle. From this elevation the light gives depth to the eyes, highlights to the cheek bones, and prominence to the chin. You may check the correct placing of this light by making sure that the shadow cast by the nose falls upon the corner of the mouth.

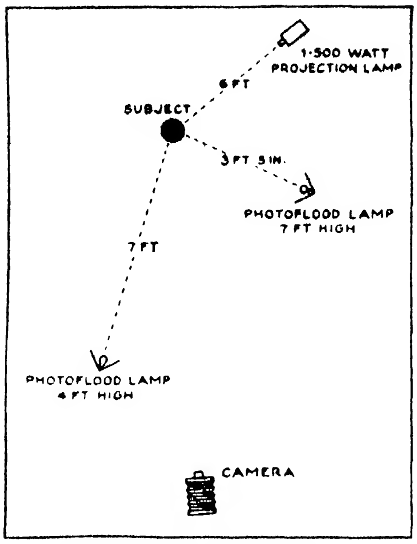
To provide general illumination so as to produce a well-balanced negative, place one



Proper placement of Photofloods

lighting unit at the side of the camera about four feet from the floor. If the lighting arrangements suggested in the accompanying diagram are followed, the effect of this light will be relatively weaker than that of the highlight unit. This is as it should be; otherwise, the modeling would be destroyed and a "chalky," characterless picture would be the result.

A spotlight, if used intelligently and merely as an accessory light, to give sparkle to the hair, to lighten up a particularly heavy shadow, or to add emphasis to some detail of face or dress, is very useful. It lends sparkle and distinction to what might



A spotlight lends sparkle . . .

otherwise be termed "just another picture."

Make your subject the dominant feature of the picture, to which everything else is subordinate; use a plain wall or gray cloth as a background and place the subject far enough away from the background to avoid casting a heavy shadow and to provide space for a small spotlight behind him, if desired. Above all, since naturalness in the final print should be the main objective, let your subject pose himself while you watch for the best moment. Then "shoot"—quickly. By the way, be sure none of the light strikes the lens directly.

Painstaking adherence to these tried-and-true pointers should result in a "bull's-eye" every time.

New Leica Model

SPEEDS up to 1/1000th of a second are provided in the new Leica Model G, the other feature of this model being chromium-plating of all parts except the body of the camera, which remains black, as in the Model F.

Universal Developing Tank

A UNIVERSAL developing tank, called the Perplex, for miniature negatives ranging in size from 35 mm. to 2½ by 4¼ inches, is made of bakelite and therefore is proof against acids. The tank is equipped with an adjustable grooved reel to take various sizes of miniature film, though in the case of 35 mm. it can accommodate only 12 exposures.

The film is loaded in the darkroom or a changing bag by feeding the film into the outer openings of the grooves after removing the paper backing from the film. After the lid is fastened, all the other operations may be carried on in bright light, from the pouring in of the developer in an opening at the top to final washing. An agitator is supplied with the tank.

Distance Meter and Range Finder

OWNERS of cameras not equipped with range finders or the reflex principle will welcome the news that a reasonably priced distance meter has been placed on the market under the name of the Bee Bee Distance Meter and Range Finder. The first photographic range finder made in the United States, its price halves that of the cheapest hitherto obtainable. Its effectiveness ranges from 2 feet to infinity, and it can be either held in the hand or attached to the camera.

The meter uses semi-transparent, gilded, dividing mirrors showing two images of the subject when the instrument is not in focus. It is the work of a moment to turn the dial, superimpose the two images—thus bringing about accurate focus—and read off the distance on the dial. Its long optical base of four inches makes it twice as accurate as the two-inch type.

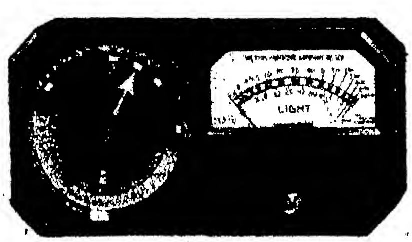
Graflex Copygraph

SERIOUS advanced amateurs often have occasion to copy old photographs—or even their own new ones, for one reason and another—drawings, charts, or what not. A compact copying apparatus, complete with lights, is offered for this purpose to owners of Graflex cameras, the Speed Graphic, and other cameras equipped for ground-glass focusing. In conjunction with a microscope it can also be used in photomicrographic work, one of the most fascinating fields in photography.

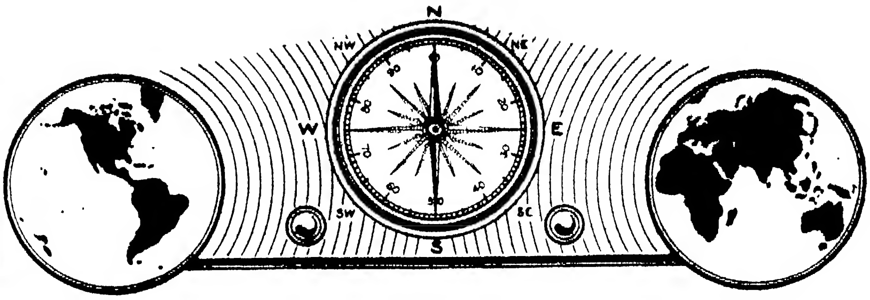
Delightfully self-contained, the outfit consists of a case into which the apparatus is packed and which when open also serves as a base and copystand for the apparatus, an upright rod, a sliding arm to hold the camera, two reflectors with extension rods permitting the placing of the lamps in any position in relation to the subject, and a switch. When not in use the whole thing is packed away into the case, either for keeping in a small space or for carrying about. A complete copying studio offering ideal facilities for this type of work, it should open up possibilities for new work to many a camera enthusiast and be particularly helpful to students, scientific workers, and those looking for a chance to make a little extra money evenings by copying photographs.

New Meter For Critical Exposure Range

CORRECT camera settings in the range of low brightness levels where exposure problems are most critical may be obtained with a new photo-electric exposure meter of increased light sensitivity. The meter is said to give exposure data for scenes less than one third as bright as that required to actuate earlier models, meeting the light conditions commonly encountered in photographing interiors, in home photography under artificial light, and in candid camera work.



A more sensitive exposure meter



WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN*

SELECTING A RECEIVER

A GOOD all-wave receiver should have the following features: (1) At least one pre-amplifier or radio-frequency stage of the tuned type operating on all wavebands. (2) Provisions for using a noise-reducing antenna of the doublet type. (3) Separate (not tapped) coils for each waveband and each coil individually shielded. (4) Automatic volume control. (5) Two tuning-dial ratios, with the highest ratio not less than 50 to 1.

A good standard broadcast receiver should have the following features: (1) A pre-amplifier stage. (2) Diode detection. (3) Automatic volume control, preferably together with one of the many arrangements to eliminate noise when tuning from one station to another. (4) At least two power amplifier tubes in the output of the receiver, connected in push-pull. Preference should be given to receivers that employ power amplifier tubes of the triode type (such as the 45), or pentodes connected to operate as triodes (such as the 42). (5) A loudspeaker of the dynamic type with a diameter no less than eight inches. (6) Some form of compensated volume control, or bass compensation system, that actually reinforces low-frequency tones rather than simulating the effect of good bass response by eliminating or attenuating tones of high frequency. (7) A cabinet, preferably of the console type, providing sufficient baffle area for the loudspeaker. A large table model cabinet may be taken as the minimum. A cabinet of smaller dimensions will reduce the effective low-frequency response.

If one must be guided by price, it is well to give serious consideration to the class of service required before making a purchase. If the quality reception of local broadcast programs is all that is desired, do not place money in an all-wave or dual-wave receiver. The manufacturer places his pennies where they do the most good, but a multiplicity of services "built in" to a moderate-priced receiver calls for some compromise. A standard broadcast receiver, minus dual-wave or all-wave features, will have more of the manufacturer's pennies invested in tone quality.

If one is not guided by price, the full merits of distant short-wave broadcasting and the high-fidelity transmissions from local broadcasters may be enjoyed from one receiver. Most of the high-priced all-wave, high-fidelity sets have proved satisfactory from both standpoints.

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

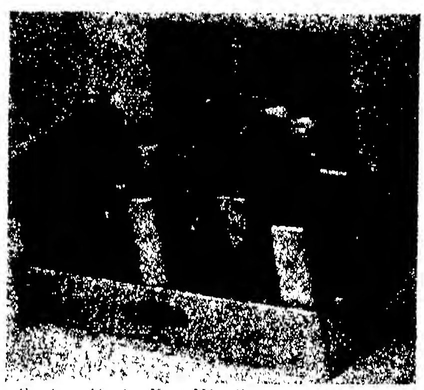
It is impossible to procure an automobile having all the worthwhile features of automotive design, unless the car is made to order. Much the same holds true with regard to radio receivers. Consequently the ultra-critical radio enthusiast can obtain the maximum in distance and high-quality reception only by resorting to a capable organization or engineer in a position to undertake the task of special design. Naturally, the cost is almost prohibitive.

METAL TUBES

THE majority of radio manufacturers have introduced all-wave and standard broadcast receivers using the new metal tubes. A typical set is illustrated below.

So far there are but ten metal tube types, eight of which replace the glass type tubes most commonly used. However, the metal tubes are not interchangeable with those of the glass type and can be used only in receivers designed for them.

The metal tubes not comparable to any existing glass types, are the 6L7 pentagrid mixer amplifier and the 6H6 twin diode. The 6L7 mixer amplifier represents quite an advance in tube design. It supplants the type 6A7 mixer-oscillator glass tube, and uses what is referred to as "suppressor-grid



Courtesy Atwater Kent Mfg. Co.

A modern radio receiving set employing nine of the new metal tubes

injection." It prevents "lock-in" between oscillator and mixer and also provides almost uniform amplification on all wavebands. Thus the use of this tube in the mixer-oscillator position in an all-wave receiver contributes greater sensitivity and improved stability.

The 6H6 twin diode is used for providing detection and automatic volume control. It is capable of handling much larger signal voltages than the diodes incorporated in the multi-purpose type of glass tube. This

greater signal handling power of the 6H6 eliminates distortion of programs due to overload and also offers certain advantages with respect to the automatic volume control system.

Generally speaking, the advantages of the metal tubes over those of the glass type are: slightly improved electrical characteristics; more rugged internal structures that serve to maintain proper tube characteristics; better shielding; less electrical circuit noise induced by mechanical vibration of the receiver; less breakage; easier insertion and removal from tube sockets.

Stratosphere Radio

THE ill-fated National Geographic-Army balloon, *Explorer II*, was equipped for broadcasting from the metal gondola on both long and short waves. The signals were to be intercepted on short-

Capt. O. A. Anderson in the gondola of *Explorer II*. Beside him are the radio receiver and transmitter

wave receivers and re-broadcast over the NBC chain. The short-wave transmitting and receiving equipment designed for *Explorer II* is shown in the accompanying illustration. It is probable that, if the balloon's bag is repaired and the projected flight is made, the same radio equipment will be used.

Western Union Radio Service

PHILCO has made arrangements with Western Union whereby any owner of a radio receiver may phone the nearest W. U. office and request radio service. The first thing you know—up pops a Philco Serviceman all set to take the kinks out of your receiver.

New All-Wave Features

HIGH degrees of sensitivity and selectivity are not requirements for local reception. As a matter of fact, too much selectivity will affect the tone quality of broadcast programs. On the other hand, sensitivity and selectivity are essential to distance reception. Therefore, the design of an all-wave receiver, which must provide both services, is quite often a compromise.

One radio manufacturer has taken care of this problem in its more expensive receivers by incorporating dual amplification systems; one with low gain and moderate selectivity for high-fidelity reception of local programs, and the other with high gain and knife-edge selectivity for the reception of distant stations on all wavebands. The listener may use either amplifier at will by the mere flip of a switch.

Another scheme, which takes care of the same problem in a different manner, employs a manually-operated, continuously variable selectivity control. With this arrangement only one amplification system is used, but its selectivity may be increased or decreased at will to meet the reception conditions, by turning a knob which alters the distance between the transformer coupling coils in the amplifier.

All-Wave Distance Reception

PEOPLE interested in distance or "DX" reception ought to have available a pair of headphones. A signal too weak to be heard from the loudspeaker will show up with considerable vigor in headphones.

Some receivers are provided with a jack so that headphones may be plugged in. With receivers not so equipped, a pair of headphones and an adaptor may be used. The adaptor looks much like a radio tube socket. Just remove the power tube in the receiver, insert the adaptor in place of the tube, and insert the tube which was removed into holes in top of the adaptor. A cord leads from the adaptor to a jack into which the headphones are plugged.

Television

IS television just around the corner? If the newspapers continue in their attempt to force the issue, there is a possibility that one or more of the leading radio manufacturers will institute such a service sooner than they would wish to.

The situation between the American press and the radio manufacturer may be likened to a young man and an impatient young lady seated on a park bench, the young lady wishing to be off to the Amusement Park and the young man refusing to rise for fear she will see the rip in the seat of his pants.

Short-Wave Converters

ANY standard broadcast receiver of the tuned radio frequency or superheterodyne type may be converted into an all-wave receiver by the addition of a short-wave converter. The effectiveness of such a combination will depend upon the merits of the broadcast receiver and the efficiency of the short-wave converter. If the broadcast receiver is satisfactory only for local reception, it will not function well as an all-wave receiver in conjunction with a converter, as the sensitivity of the receiver is the prime determining factor.

There are but two possible advantages to be gained in using a short-wave converter; a desire to retain the broadcast receiver, and the saving to be gained in purchasing a short-wave converter rather than a complete all-wave receiver.

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Books SELECTED BY THE EDITORS

THE ART OF INVENTING AND WHAT TO INVENT

By Raymond F. Yates

WHILE it may be truthfully said that no list of needed inventions is necessary to the inventor, the author does devote four pages to a list of 77 articles that still remain to be invented. Everything which touches on our daily life can be improved and such improvements, in general, are inventions. Nevertheless, Mr. Yates has produced a book which we predict will have a wide sale and which undoubtedly will serve to put many embryo inventors on the right track. The author does not deal in platitudes but offers fundamentals which any would-be inventor can use to advantage. He deals with such things as what an inventor should know about mechanics, chemistry, electricity, sketching and drawing, and manufacturing methods. Patentable and unpatentable inventions are described in a few pages and the reader is put on the right path regarding applications for patents and his relations with patent attorneys. Three excellent chapters are those entitled "How Inventions Are Sold," "Pricing Inventions," and "Selling Unpatented Inventions." An appendix giving rules of practice in the United States Patent Office covers 63 pages and is well worth reading by anyone contemplating application for a patent.—$3.15 postpaid. *A. P. P.*

A FRESHMAN GUIDE TO WRITING

By Prof. Bernard L. Jefferson and Prof. William D. Templeman

WHILE this volume is intended as a text book for students, it can be studied with much profit by thousands who are far past the freshman stage. We recommend it to those who have reports to write, particularly engineers and employees in industrial publicity departments.—$2.00 postpaid.—*F. D. M.*

HEROES OF THE AIR

By Chelsea Fraser, author of "The Story of Aircraft"

THE 13th printing of this admirable book brings it up to date to the summer of 1935 and includes the now well known proposed commercial air route across the Pacific and the test flights which have already been undertaken over this route. The 744 pages of the book cover the subject of its title from the earliest days of flying up to the present time. The first chapter is devoted to a summary of the past and present of flight, while the second chapter plunges directly into the first transatlantic flights in 1919. From this point forward the author presents a running story of the more spectacular flights which have been made since that time. The text is supplemented by 56 maps which in themselves present vividly the progress that has been made and is still being made. $2.70 postpaid. —*A. P. P.*

MODERN CRIMINAL INVESTIGATION

By Dr. Harry Soderman and Deputy Chief Inspector John J. O'Connell

IF you are writing detective fiction these days—and who isn't, judging from the number of "pulp" detective magazines?—you will positively need this book to check on your facts. To the student criminologist however, and all those who are interested in the many applications of science to criminal investigation, this book will prove most informative, and so interesting that it will be impossible to lay it down once it has been started. These two experts carry you through the entire range of scientific criminal investigation to show you how the tiniest clue is examined minutely and often will lead to the criminal. Detective story addicts will read this so that later they may, with much glee, pick flaws in some of the very unscientific detective fiction that is now on the market.—$3.20 postpaid. —*F. D. M.*

HODGE-PODGE PHOTOGRAPHY

By Edwin D. Benedict

"EARNING Money Via The Camera" is the sub-title of this little book which, despite the fact that it is atrociously written and very poorly printed, goes straight to the heart of the subject. The author writes from his own experience and does not, as is so often the case, mislead the reader into thinking that he can become wealthy overnight by taking pictures. Sound, common-sense instructions are given for photography under varying conditions and whether or not you want to make money with your camera, you will find much in this little book that will improve your photography. 144 pages, 5½ x 7 inches, paper covered.—$1.00 postpaid. *A. P. P.*

THE BINARY STARS

By Robert Grant Aitken

THE director of the Lick Observatory, a noted specialist on double stars, has revised his well known treatise, entirely rewriting some of the chapters in the light of the new knowledge of the subject gained by science since the edition of 1918 appeared. This is the standard treatise on its specialty. It covers the history, observing methods, and detailed theory, and is a technical treatise in full. It is now virtually a new book. $3.75 postpaid.—*A. G. I.*

DIET AND LIKE IT

By Mabel E. Baldwin

THIS book, which opens with an introduction by Daniel C. Darrow, M.D., of the Yale University School of Medicine, is dedicated to two main ideas: (1) that diets should be safe diets, and (2) should require no special cookery. The methods recommended are not monotonous or hunger diets but consist of correcting errors of appetite. A practical diet book for fat men—and others.—$2.65 postpaid.—*A. G. I.*

MECHANICS AND APPLIED HEAT WITH ELECTROTECHNICS

By S. H. Moorfield and H. H. Winstanley

NO reviewer could expect to peruse this book completely as it is a text-book of mathematics and diagrams. While the authors explain that it was written with the object of producing a course in engineering science for the student, it is, in our opinion, more adaptable to the needs of a relatively advanced engineer. In 328 pages, most fields of physics are covered, starting with force and its effects, strain and elasticity, equilibrium of forces, friction, motion, energy, hydraulics, heat, and so on; in 63 pages is given a very concise outline of the fundamentals of electricity. $2.40 postpaid.—*F. D. M.*

SCIENCE AND THE PUBLIC MIND

By Benjamin C. Gruenberg

THIS book presents a survey of conditions in an age in which scientific advances and study have reached their

SCIENTIFIC AMERICAN

An Amateur Astronomer's Home-Made Telescope (See page 169)

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(Audit Bureau of Circulations) **(Active Reference Users)**

SCIENTIFIC AMERICAN, now in its 90th year of uninterrupted publication, fills an essential need and performs a public service. No other publication performs a similar function, and its distinctive contribution to American life cannot be duplicated.

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Measured in numbers, the readership of SCIENTIFIC AMERICAN is not large, and never will be large. Its editorial standard is too high either to appeal to or to be appreciated and understood by the mass mind, yet the SCIENTIFIC AMERICAN readership, in its influence and purchasing power, is an unexploited and unused market for many advertisers desiring to reach those who pioneer in Commerce, Industry, School, and Government.

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Constantly used as a reference, every issue has a circulation at least ten times greater than the numerical count of 31,602, credited it by the Audit Bureau of Circulations, of which it is a member.

The Editorial Staff of SCIENTIFIC AMERICAN has always had the co-operation of distinguished leaders in all fields of Science. They serve as contributing editors.

It is our privilege to announce that beginning with the September issue, the readers of SCIENTIFIC AMERICAN have the benefit of the counsel of **VLADIMIR K. ZWORYKIN**, Director, Electronics Research Laboratory, RCA Manufacturing Co., Victor Division, Camden, New Jersey, as a contributing editor.

ZWORYKIN, VLADIMIR, K.: Born 1889 in Russia. Received E. E. degree, Petrograd Institute of Technology in 1912, where he studied physics under Professor Boris Rosing, and where he also started his first experiments in television. In 1912 he entered the laboratory of the Collège de France in Paris, to do X-ray research under Professor P. Langevin. During the World War served in Russian Army as an officer in the Radio Corps. In January, 1919, came to the U. S. A., and from 1920 to 1929 was a member of the Research Laboratory of the Westinghouse Electric and Manufacturing Company. Received Ph. D. degree, University of Pittsburgh, 1926. In 1929 was transferred to the RCA Victor Research Laboratory in Camden, working on television, electron optics, photoelectric cells, and allied problems. Was made director of the Electronic Research Laboratory of the RCA Manufacturing Company in 1934. In the same year he received the Morris Liebmann Memorial Award for his contributions to the development of television.

Dr. Zworykin is the author of a number of papers on photocells, sound recording, facsimile, television, and electron optics, and co-author of the book, "Photocells and Their Applications," which have attracted international attention.

SCIENTIFIC AMERICAN

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

CONTENTS · OCTOBER · 1935

COVER

PERHAPS, because of its grandeur, astronomy has become the most popular branch of science among the public. Many amateur astronomers own excellent astronomical telescopes, and of these a large number have been home-made from published instructions. Our cover photograph shows a typical telescope of this kind—a Newtonian reflector made by Cyril G. Wates, a telephone engineer of Edmonton, Alberta, Canada. Its aperture is nine inches and it magnifies over 100 diameters. Perched 200 feet above the Saskatchewan River, Mr. Wates' observatory commands a wide and romantic view of the nearby earth and the skies. He believes it to be the most northern home-made telescope on the continent. For further data, see page 214.

The SCIENTIFIC AMERICAN DIGEST

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ACROSS THE EDITOR'S DESK

THERE has been a close and sympathetic bond between the Navy and SCIENTIFIC AMERICAN for so many decades that a tradition has grown up linking the two in a common, patriotic purpose. As the American "Journal of the Peaceful Arts," SCIENTIFIC AMERICAN has always considered the Navy not as an instrument of war but one which, by commanding the respect of other nations, keeps the United States out of other people's wars and leaves us free to pursue our chosen path to progress and prosperity.

Our Navy tradition, the breaking down of the Naval Limitations Treaties, the enlargement of fleets by world powers, the Treaty-limited naval building program of the United States, the rumored building program of Great Britain—these things together with the fact that SCIENTIFIC AMERICAN and the United States Naval Academy at Annapolis both celebrate their 90th Anniversaries this year, make it fitting that we should publish our November issue as a Navy Number, the release date to be October 18th, just nine days prior to Navy Day, October 27th.

Through the co-operation of the Navy Department of the United States and of other naval authorities, we will present in our Navy Number a variety of special features, all of which have an important bearing on both national defense and national prosperity. Editorially we shall discuss the necessity for a Navy strong enough to carry out the peaceful policies of the United States. Another feature will deal with naval problems in the Pacific, this latter discussion giving reasons for, and the extent of, our interest in the Pacific, and offering a solution to this disturbing problem.

Secretary of the Navy Claude A. Swanson, Assistant Secretary of the Navy Henry L. Roosevelt, and Chief of Naval Operations, Admiral William H. Standley have co-operated in producing this issue. This triumvirate feels strongly on the subject of national defense and particularly as it pertains to sea power. They have, therefore, given us original statements stressing the importance of the work which we hope to promote in some slight measure with our November issue.

What might be considered the two major features of the Navy Number will be "Fifteen Years of Naval Development," by Captain Jonas H. Ingram, U.S.N., and "A Forecast of World Navies," by Dr. Oscar Parkes, for 16 years editor of the world-famed publication "Jane's Fighting Ships." Post-war problems and naval limitations' treaties have laid the onus of national defense more heavily upon the shoulders of technical men and they have made great strides in developing a finer and more efficient Navy. Therefore Captain Ingram's article is extremely important, covering as it does this period of momentous development. Looking to the future, Dr. Parkes gives us an idea of what we may expect in the design and fighting ability of ships that will be built by the naval powers. Dr. Parkes makes some original suggestions which should provoke much thought and discussion among naval architects and constructors.

> **Our November issue will be a**
>
> **NAVY NUMBER**
>
> **It will also contain a generous amount of other scientific material.**

Captain Ingram also writes of Annapolis, giving the traditions and spirit of this fine old institution with its background of 90 years of service to the country as a trainer of superior naval officers and a maker of men who rank high in civilian life. Another article will concern itself with the healthy influence the Navy exerts on progress in industry. The Navy made possible the famous Whirlwind airplane engine, was the first user of aluminum foil insulation, perfected a Diesel which was the forerunner of the American Diesel engine industry, and demands perfection in such a host of other things that industry has gained tremendous rewards in developing the technique to fill satisfactorily the Navy's needs. Still another article, discussing lucidly the uses of aircraft in the Navy, disposes of the old myth that aircraft have spelled the doom of surface vessels. In this, as in Captain Ingram's first article, the statement is made that the battleship is still the backbone of the fleet. Radio, of course, has become of great importance in the field of communications, so another major article by a naval authority will cover this subject.

We now come to a feature that is tremendously important. This is a dramatized map of the United States, done attractively in wash and suitable for framing, showing the contribution which each of the 48 states makes toward the construction of a typical naval vessel. Often the statement is made that there are certain states which do not even realize that the country is surrounded by water and can see no need for the expenditure necessary to maintain a navy. This map, with its appended notes, will show that practically every state supplies thousands of dollars' worth of material or equipment for ships that are built, thus aiding state industries. The significant facts brought out by this feature will, we feel sure, prove most interesting to all, as they are not generally realized.

Needless to say, the November issue will also contain a generous amount of other scientific material. The entire number will be presented in attractive fashion and we hope that all readers will consider their copies worthy of preservation for future reference in connection with naval questions.

Orson D. Munn

Editor and Publisher

Photo by Newton H Hartman

ORDER X—PRIMATES
SUBORDER III—ANTHROPOIDEA
SECTION B—CATARRHINI
FAMILY II—SIMIIDAE and
FAMILY IV—HOMINIDAE

HER old man has been fed and has gone off to the club, the dishes are done, and Mrs. Jones now finds time to sit out on the front steps with the baby in her arm and pick her teeth while she enjoys the autumn sunset and relaxes a bit after a hard day over the cook stove. She is thinking vaguely about nothing in particular. Reader, you are not asked to believe that this orang is our poor relative, but the scientific evidence points that way. And we have seen humans whose looks we liked less. This is "Guarina," at the gardens of the Zoological Society of Philadelphia, and she is from Sumatra.

Intensive breeding of wheat insures better flour for bread, pastry, and other bakery products

Agricultural Research Aids Industry

Co-operation Brings Results . . . Better Crops Are Produced . . . New Industries Born . . . Old Ones Benefited . . . Ultimate Consumer Reaps a Harvest

By JAMES T. JARDINE
Chief, Office of Experiment Stations, U. S. Department of Agriculture

MANY of the facts and principles upon which the relationship between modern agriculture and the nation's industries is based have been accumulated during the past half century as a result of the combined research efforts of the state agricultural experiment stations and the United States Department of Agriculture. Prominent among related industries are those engaged in the manufacture of a wide variety of chemical and biological products and by-products such as are used not only in improving farming practices but also in providing many of the essentials as well as comforts and conveniences of the every-day life of the average citizen.

The interests of processors and distributors of food and clothing materials of plant and animal origin are served by the experiment stations in a more or less obvious and direct manner. As a class they are probably the biggest industries benefited by agricultural research and their business aggregates a value somewhere near 14 billion dollars annually. Manufacturers of fertilizers, sprays, and many other chemical commodities, and the producers of mechanical and electrical equipment also have long standing relationships with the stations.

The production of field, fruit, and vegetable crops and their preparation and processing for human and animal consumption, as foods or otherwise, have almost unlimited industrial implications and relationships. The more evident problems of production are subjects of extensive study by the experiment stations, owing to their economic importance. Around each of these have been built commercial industries which manufacture many commodities and types of equipment necessary in the production of crops.

Farmers have found that the most convenient and uniformly profitable procedure, supplementing the proper selection and adaptation of natural soil resources to crop production, is the rational and intelligent use of fertilizers. Bringing to light the specific food requirements of growing crop plants and the development of fertilizer manufacture and use on a sound basis have been among the major activities of the experiment stations and the Department of Agriculture for a long period of years. This work has provided a foundation of

Experimental development of machinery for cultivation and weed control removes much of the guesswork from machinery manufacture and retail selling

principles governing the practical use of commercial fertilizers by farmers which reached a high point of more than eight million tons in 1930. The use of high grade and concentrated fertilizers has greatly increased with gains in efficiency and savings in cost of transportation and handling, and more efficient means of applying fertilizers have also resulted. Both agriculture and the fertilizer industry have profited by this intensive research.

EXPERIMENT station research also has revealed that growing deficiencies of some more or less rare elements in otherwise normal soil may cause crop failures. Recent instances were the discovery of the essential character of zinc, both in preventing and reducing the severity of bronzing of tung oil trees and of little leaf, rosette, chlorosis, and similar physiological disorders of walnuts, citrus fruits, grapes, apples, pecans, and peaches, and the development of effective zinc sulfate treatments. Similarly, the essential character of manganese, copper, boron, and other elements has been established in the nutrition of important crop plants. Such researches have resulted in saving crops of considerable total value and have increased the business of the chemical industries.

Research at the experiment stations with insecticides, particularly the oils and oil emulsions and arsenicals, has led to their every-day use for the protection of plants and animals against insect pests, and has resulted in the commercial manufacture and marketing of products valued at several million dollars annually. For example, experiment station research resulting in the extensive use of crude oil emulsion and miscible oils for control of scale insects, red spider, leaf roller, and other similar pests, also has resulted in corresponding chemical industries of considerable magnitude.

Not only do weeds decrease materially the profits from crops by increasing costs of production and reducing yields but they bring about a decrease in land values. The national toll from weeds approximates 400,000,000 dollars annually. Practically every experiment station in the United States, as well as the Department of Agriculture, has studied problems of weed control which are of interest to the machinery and chemical industries.

Mechanical methods and equipment of commercial importance for the control of weeds in crops have been developed. More recently progress has been made in the development of chemical control methods, including especially the successful use of arsenic compounds for the sterilization of soils against weed growth in walks, driveways, roadsides, fence lines, parking spaces, railroad rights-of-way, drainage and irrigation ditch banks, and in other similar areas. Other studies have developed the effectiveness of sodium chlorate and acid arsenicals for the control of certain of the more important weeds on cultivated soils, resulting in their wide use in agricultural areas. Also mechanical equipment has been perfected for applying various chemicals, such as sulfuric acid, for effective control of weed growth.

The fruit-growing industry of the United States produces crops valued at hundreds of millions of dollars annually. In order to protect this vast industry against partial or total loss due to late frosts, orchard heaters, developed in their present state of efficiency largely as a result of experiment station research, are used to heat the air surrounding the trees on cold nights. The majority of these heaters burn low-grade fuel oil. In California alone there are 3,300,000 such orchard heaters, of which about 3,000,000 burn low-grade fuel oil. It requires 2500 railway tank carloads of oil to fill these heaters once, and as much as 15,000,000 gallons of fuel oil frequently are burned in one night in protecting the citrus crop of that one state against frost damage. The manufacturers and oil companies utilize the information secured by the stations to produce more efficient and economical heaters and fuels which will not create a smoke nuisance. Such heaters are now used widely where valuable fruit crops are produced.

THE adaptation of electricity to agricultural practices and processes began to assume a position of considerable industrial importance more than 10 years ago. As many as 28 of the state experiment stations, co-operating with utilities and equipment manufacturers, have engaged in research on the utilization of electricity in agriculture during the past 10 years, not only for the conventional household uses but for many production operations. This has entailed especially the adaptation of electric equipment to farm requirements. The result has been a marked increase in the use of electrical energy for stationary farm production operations, including feed grinding, poultry incubating and brooding, irrigation pumping, wood sawing, hay hoisting, dairy equipment and product sterilization, milking, cream separation, grain threshing, greenhouse and hotbed heating, crop processing, and for many other purposes. Research has resulted to date in some 227 practical applications of electricity to agriculture and 2,250,000 rural customers, of which a third are farmers. The annual consumption of electricity on more than 713,000 farms now averages nearly 1,635,000,000 kilowatt hours.

Forty-six of the experiment stations, in co-operation with the Department of Agriculture, have conducted nation-wide studies of farm housing and its requirements to develop designs of farm homes and buildings which are adapted specifically to local conditions and climates and combine convenience, comfort, economy, maximum serviceability, and durability. Farmers, building contractors, and commercial dealers in building materials have been quick to take advan-

tage of these services of the stations and have co-operated to the fullest extent. The industrial significance of this work is indicated by the fact that in 1930 farm buildings of the United States represented an investment of approximately 13,000,000,000 dollars, of which 7,000,000,000 dollars were for dwellings and 6,000,000,000 dollars were for production structures.

The relation which livestock production bears to the great meat-processing and meat-packing industries is well known. The livestock products industry is immense, being valued at more than three and a quarter billion dollars in 1931. Packed meats alone were valued at 2,180,000,000 dollars during that year. Back of the development of the livestock industry stands the experiment station system with its comprehensive program of research for economical production of and quality in meats, milk and milk products, hides, wool, and other products and by-products.

Animal disease prevention and control is no small part of the experiment station research program in the unceasing efforts to protect the public and insure quality in livestock products. In that connection a sizable commercial industry has been built up for the production of serums, vaccines, and chemical treatments for diseases and parasites.

Crop products are used universally for food, clothing, or some other purpose. Aside from direct uses as food are many uses which involve the commercial industries as necessary processors.

Bread and other bakery products are probably the most important crop food products from the standpoint of the total population. The baking business is valued annually in billions of dollars and employs hundreds of thousands of people in flour mills, bakeries, and wholesale and retail stores.

THE national milling and baking industries are based upon years of research, much of which has been conducted by the experiment stations in co-operation with the Department of Agriculture, not only in the selection, breeding, grading, storage, and improvement of wheat, rye, corn, and other grains, but also to some extent in the physics and chemistry of milling the grain into flour, the manufacture of dough of the proper characteristics, and baking doughs into the different commercial products such as bread, crackers, doughnuts, pastry, pretzels, and other foods. A majority of the stations have served these industries in the production of grains specifically adapted for the different baking purposes. Others have made contributions to the technique of milling and baking through researches in cereal chemistry.

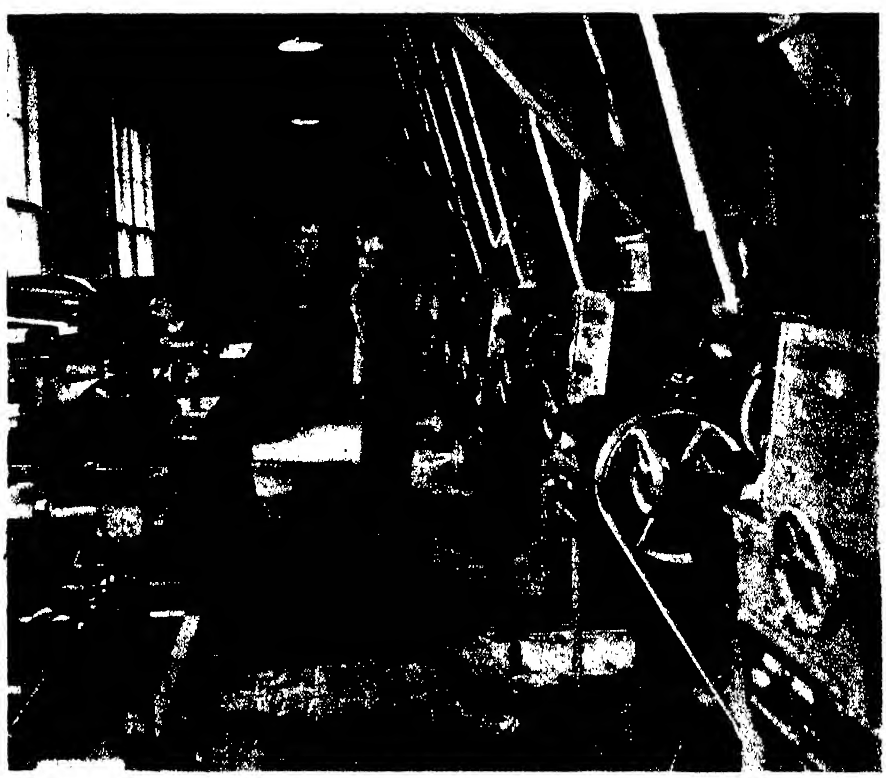
Orange juice and grapefruit are used largely as sources of the necessary vitamins in the diet. Largely by virtue of research, the average citizen is able to secure fruit of high quality, uniform grade, and protected against spoilage in transit. The relationships of this work with commercial enterprises include especially those with the packing, canning, container manufacturing, transportation, refrigeration, processing, and chemical by-product industries.

Among the textile crops, cotton is of outstanding importance. In 1931 the value of cotton goods textile materials produced in the United States was over 800,000,000 dollars. Experiment stations in the South have studied spinners' requirements and the characteristics of the crops in different localities and supplemented this by variety trials, breeding, and physical tests. By virtue of this research a large proportion of the cotton crop in several states has been improved in staple lengths, uniformity, and physical standards required by the textile mills to provide the materials essential in the wide variety of cotton manufacturing processes and products employing cotton.

THE canning and quick freezing of fruits and vegetables have developed into sizable commercial industries. Here again the experiment stations have taken an active part in breeding fruits and vegetables especially adapted for these purposes and in contributing to the technique of the process by safeguarding the quality of the product from the standpoint of the consumer. A northern station has co-operated with one of the leading commercial freezing companies in testing strawberries, raspberries, cherries, peas, and corn on the cob for freezing purposes.

The research at certain western experiment stations in co-operation with the Department of Agriculture on storage, precooling, and handling of fruits and vegetables designed for distant markets has been of great value to the railroads and other commercial transportation and marketing agencies. The significance of these researches can be appreciated when it is considered that in 1932, for example, 84,683 carloads of apples, 81,320 carloads of oranges, 46,215 carloads of grapes, and 46,681 carloads of lettuce were transported by the railroads, to say nothing of large shipments of other popular fruits and vegetables, all perishable.

It has been possible here to draw attention to only a few of the more obvious relationships which exist between the work of the agricultural experiment stations and the nation's industries. Many other examples and illustrations might have been cited. These numerous relationships have done much to eliminate or reduce many of the hazards of agricultural production and to increase the efficiency and lower the cost of production and marketing to the mutual benefit of agriculture, industry, and consumers. Superior crop and animal products and by-products have evolved which influence the comfort and welfare of every citizen. And lastly, the productive capacity of the farmer and of the industrial worker has been increased many fold.



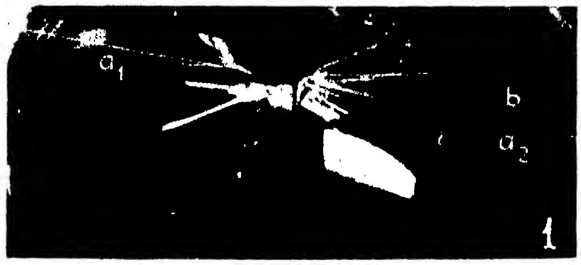
Wheat produced by intensive breeding experiments is put through an experimental mill in order to determine the milling qualities of the various types

Building Blocks of the Atom

Artificial Disintegration Leads to Knowledge of How Atoms Are Made . . . A Round-up of Terms

IN 1917, Robert A. Millikan published a book called *The Electron*, which contained most of what was then known about the atom. The book, now revised, emerges this year as almost an entirely new creation. Its present title suggests the lengthy strides science has taken toward an understanding of the microcosm during the last 18 years. The book is called "Electrons (+ and −), Protons, Photons, Neutrons, and Cosmic Rays." Had the author wished to be even more inclusive, he might have added *alpha* particles, deuterons, and neutrinos to the list.

The development of experiments to break down or build up the nucleus of an atom by bombarding it with high-speed particles is probably responsible for these tremendous advances in our knowledge of what the atom is made of and how it is put together. The three remarkable photographs on this page, from Dr. Millikan's book, show the element lithium actually in the process of disintegration, under fire of tiny projectiles. The lithium target is at the center, and the thin white lines are tracks of particles knocked from the atomic nuclei.



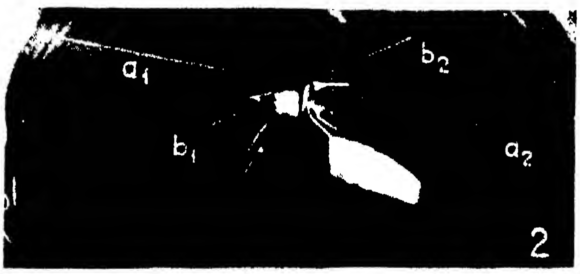
The lithium target at the top is under fire of a stream of heavy hydrogen cores, and is shown actually in the process of breaking up. The lines a_1 and a_2 are alpha particle tracks

WITH science progressing so swiftly, it is well sometimes to pull up and take inventory. Up to date there are some eight chief terms which scientists use in connection with the atom.

Electron. The negative electrons revolve in orbits about the nucleus of the atom, neutralizing its positive charge. They are identical with the *beta* particles which escape from radioactive substances. The most modern theory holds that electrons are not particles but wave trains. Since they have the properties of both, someone has suggested "wavicles" as an appropriate name.

Positron. The positron is a positively charged electron. It occurs far less often in nature than its companion, a fact which is not yet adequately explained. It does not exist within a normal atom, but when cosmic rays or *gamma* rays penetrate the nucleus, a positron and an electron may be created together, probably representing a transformation of radiant energy into mass.

Proton. Protons are the cores of hydrogen atoms, and are a primary building block in all nuclei. They are almost 2000 times as massive as the positron, but they bear the same charge as the positron.



Each lithium atom squarely hit by one of the hydrogen bullets disintegrates into two alpha particles. a_1 and a_2 mark the tracks of such a pair. b_1 and b_2 are caused probably by rapid protons

Neutron. The neutron is a particle with approximately the same mass as a proton, but without any electrical charge. It is likewise a primary constituent of atomic nuclei.

How the four particles thus far mentioned are related to each other is still uncertain. It seems probable that a neutron is made up of a proton plus an electron. It is also possible, however, that a proton consists of a neutron and a positron. Before the discovery of the neutron in 1932, it was assumed that the nucleus must contain some free electrons to balance part of the positive charge; now it is generally conceded that if electrons are present at all, they exist within the neutron.

Simultaneous emission of many pairs of alpha particles. The shorter tracks are chiefly due to protons. The faster a particle moves, the longer track it makes

Alpha particles. These are the cores of helium atoms, made up of two protons and two neutrons. The protons and neutrons within the nuclei of complex atoms tend to group themselves in these compact, stable units. When elements disintegrate, either radio-actively or under bombardment, *alpha particles* are frequently emitted, as shown in the accompanying photographs.

Neutrino. No scientists can say definitely that this infinitesimal, chargeless particle really exists, for it has never actually been identified. If the law of conservation of energy holds, however, one must assume that it does. In radioactive disintegration, similar atoms emit *beta* particles of different energies, yet still remain similar.

Deuteron. This is the nucleus of the famous heavy hydrogen atom, the isotope which weighs twice as much as ordinary hydrogen, but behaves exactly the same in other respects.

Photon. According to the quantum theory, the photon is a unit of radiant energy. Although photons are not direct constituents of atoms, they are radiated whenever there is a loss of energy within the nucleus or the extra-nuclear structure.—*Jean Harrington*

OUR POINT OF VIEW

Uniform Traffic Laws

PROBABLY the greatest bugbear which the motorist has to face today is the wide diversity of traffic laws which he finds in different states and even in different communities of the same state. Here he is allowed to turn right on red. There he is not. Here he turns to the left of a traffic post, there it is required that he go to the right. Here he parks parallel to the curb. There he must head in at an angle, and in a third place he must back in at an angle. Speed laws show as wide variety. This bridge can be crossed only at a speed of less than eight miles an hour. On this highway it is required that he maintain at least a 35 mile an hour speed or else receive a summons for obstructing traffic!

These brief statements show the great need which exists for some uniform method for regulating the flow of traffic. True enough, uniform laws would reduce to some extent the revenue acquired by a certain few grasping politicians in the smaller communities who feel that motorists passing through are their legitimate prey and who therefore enact trick traffic laws which are designed for no other purpose than to trap the unwary and thereby add to the exchequer of the community. But this is a small-time way of looking at the matter. The automobile has made possible a vast expansion of our nation. It provides a means of transportation which has made it possible for the average man to travel widely and to learn more about his own country than would be possible in any other way. On the other hand, of course, the automobile has shown itself to be a dangerous weapon when in the hands of irresponsible drivers, and particularly so when these same drivers are faced by ever-changing and never-uniform traffic regulations.

If when a motorist approaches a crossing he knows that his actions will be governed by the same laws as pertained at the last crossing; if he knows that he is not going to be summoned for a traffic violation by a small-town police officer who is over-zealous in his duties; and if he knows definitely that the law is on his side rather than against him, many of the psychological dangers of motoring will be eliminated.

Here is a case where the oft-discussed states' rights must be disregarded. Small communities can no longer be a law unto themselves when the good of the greatest number is to be considered. There must be developed a uniform set of laws which will apply in all localities throughout the country. Such a set of regulations can best be arrived at by a study of the situation as a whole and by collaboration between state and federal authorities. SCIENTIFIC AMERICAN lends its voice in demanding that such co-operation be secured and that all possible speed be made in securing for the motoring public the safety of uniform traffic regulations.

Forgotten Inventors?

THERE is no need to argue the question that the inventor is the very backbone of our present-day civilization. Without a constant supply of inventions, our present rate of progress would be impossible. It seems, however, that the Patent Office, established for the purpose of assisting the inventor to protect his property, is overlooking the fact that in many cases the question of financing the securing of a patent is a very serious one. In these times of financial stress, it appears that the United States Government has forgotten that there are many workmen and mechanics out of jobs who have turned their idle hours to perfecting inventions but unless these men can obtain proper protection in the form of a patent, their inventions are frequently of little value to them. No doubt there are many inventors who would seek patent protection but who cannot afford to pay the fees now required by the Patent Office —30 dollars on filing his application, whether he gets a patent or not, and 30 dollars more, should the application be allowed, in order to have his patent issued.

There was a time a few years ago when the filing fee was only 15 dollars and when the final or issue fee was only 20 dollars. At that rate, the Patent Office was not only self-sustaining but showed an excess of receipts over the cost of maintenance. Of course, the time required to make an examination of an application to determine the patentability of its subject matter has greatly increased, but the same may be said of all activities in all departments of government. It would seem to us to be a worthy action on the part of our existing administration to take into consideration the value of the work being done by inventors and to give them a break during hard times. A return to the former 15 and 20 dollar fees might make it possible for the Patent Office to be self-supporting: At any rate, this step would be of material assistance to those inventors who simply cannot afford to pay the fees now exacted. Who can tell what beneficial results might accrue from such a procedure?

Breaking into the Weather's Lair

BEHIND the trans-polar flights of the Russians lies more than a stunt. The flights were inspired by Professor Otto Schmidt, a scientist, head of the Arctic Institute of Leningrad. What Professor Schmidt and the Arctic Institute have had in mind is to fly clear across the polar regions and prospect out suitable sites for meteorological observatories. To Russia this is of especial importance because temperate zone weather comes from the Arctic and she is literally wrapped around the Arctic regions. At present there is a network of weather observatories covering, quite densely, most of the North Temperate Zone. The circumpolar region is a great gap in this world network and, since "highs" and "lows" of the temperate zone mainly originate closer to the pole, this gap happens to fall just where it is most embarrassing to weather forecasters.

To place a meteorological station serviced by airplanes at the exact Pole is a feat which, of course, makes appeal to the imagination but too much emphasis has been placed by newspaper writers on this aspect of the plan. The North Pole lies inconveniently in the midst of an ocean 1000 by 1500 by two miles in dimensions, on pack ice. What science wants is as dense a network wherever there are existing gaps as there now are elsewhere; no doubt the Pole would be one chosen site, however. The need has been well explained by the weather forecaster H. H. Clayton, in a scientific book entitled "Problems of Polar Research," edited by W. L. G. Joerg of the American Geographic Society, New York, a society of scientific geographers. Such stations, supplied with kites, sounding balloons, or airplanes of their own, could catch the storms of the temperate zone where they are whelped and, by reporting them by radio three times daily, they would permit forecasters to predict with less guesswork.

Whatever results the Russians ultimately obtain in this work will be equally helpful to us, since our weather, too, comes from the circumpolar regions. Therefore we should co-operate with them.

The great city mound of Tepe Gawra, in Irak. The mound represents 20 cities, one on top of another. In the Orient, the building materials—bricks of sun-dried clay—dissolve in the rain. It is easier to level off a half-ruined building, bring in more material and start on top of the last, than clear off and start anew. Hence the "pile" of city levels in stratified order

THE GREAT MOUND OF TEPE GAWRA

By JOTHAM JOHNSON
The University Museum, Philadelphia

IN the sixth millennium before Christ, a migrating horde swept from the east over India, Persia, and Mesopotamia. Many more waves of invasion were to break over the hills and valleys of these lands; it is not even likely that this was the first. But we still know so little about the early movements of man in Mesopotamia that we cannot say whether any race was there to receive this horde, for wherever their remains have been found they lie at the bottom of all other identifiable human remains.

Their most typical product was their earthenware vessels, for cooking and other household purposes, painted with distinctive geometric designs. This pottery has already been found in test pits and trial trenches at such sites at Tell Kukuteni in Baluchistan, at Susa and Tepe Hissar in Persia, at Tell Halaf and Nineveh in northern Mesopotamia, and at al-Ubaid near Ur in Babylonia; but with it has come to light nothing of the culture, no associated objects, only broken sherds of the vessels themselves.

In spite of the vast territory these peoples once controlled, literally nothing has been known about them—nothing about their racial type, their language, their arts and crafts, nothing except that they painted their pottery. For lack of any better description they may be called the "painted pottery peoples." Yet in the history of mankind no race now presents at once so potentially important a position together with so deep a mystery. It will call for the intense archeological endeavors of many scholars for the next generation.

The most sensible first step is the systematic one: to select some one city of this race and excavate it soberly and quietly. If written tablets are not found we must be content to watch for the muter testimonials of such sombre finds as potsherds and bone pins and obsidian razors and the battered stubs of mud walls. When by these means we have reconstructed the culture of this people, in some of its tangible aspects, at one city, we may turn to survey from a new and higher observation post the other unclassified primitive vestiges which tend to be associated with these remote peoples.

IN 1927 Dr. E. A. Speiser, exploring the mounds clustered in the upper Tigris valley, paid particular attention to the "great mound," Tepe Gawra. It had been observed by previous travelers but its significance had not been suspected. Later that year Dr. Speiser was able to run a successful and enlightening trial trench with funds supplied by the American School of Oriental Research in Baghdad. Of 20 cities neatly stratified on the tell, the lowest nine showed painted pottery as their typical find—a stimulus to further exploration.

Without this pottery the excavation of Tepe Gawra would have been reserved for a future generation. To the University Museum, however, the prospect and the privilege of realizing not one but nine cities of the painted pottery peoples was irresistible; and in the friendly rivalry between institutions competing for the honor of leading the journey back to man's origin, the approaching completion of our work at Ur suggested the choice of a still more ancient site. An alliance was struck with the American School in Baghdad, and with Dr. Speiser as field director, assisted by Mr. Bache, work was begun at Tepe Gawra, Level 1, in 1930; this in face of the depression and the expensive and potentially thankless task of clearing away the overlying debris of 11 later strata in order to clear the mound for the real work. Later, when Levels 6 and 8 yielded their extraordinary cultures, adding new chapters to history, and Level 9 gave up the burial chambers with rich finds of gold and electrum reported by the press of the entire world, the importance of Tepe Gawra's succeeding civilizations received due recognition.

None the less, Level 12 remained the real goal of the excavators for eight years. By exploring thoroughly the city of this level, and then earlier levels in turn right down to level 20 which may go back to 5500 B.C., the story of the architecture and of the arts and crafts of this ancient tribe, and, if luck favors, some account of their religious worship, will be unrolled.

Level 12 was partially uncovered during the 1934-5 season, and the first news of the architecture of the painted pottery peoples is here given. Press reports, stating that part of Level 13 was laid bare and giving a name to the town, are erroneous; but the statement that Level 12 goes back to about 4000

B.C. has the approval of Dr. Speiser and Mr. Bache. The city was 3000 years old 3000 years ago when Homer sang of Troy.

Over the area was a heavy layer of ashes and charred refuse; the city had been destroyed by fire. When this had been cleared away the forms of the building walls began to appear; they were of *libn*, mud brick, the typical material of Mesopotamia; yet Tepe Gawra is in sight of the Kurdish mountains. If the painted pottery peoples had originated in a mountain country with architecture in stone, we would have expected them to use the more familiar material; or else by the period of Level 12 they had lived so long in Mesopotamia as to adopt the customs demanded by the country. In any case, the architecture surpassed that of the three succeeding periods at Tepe Gawra. One large building was so extensive that it may have been the palace of a chief. Of the many rooms the largest measured about 37 by 17 feet; its walls were coated with fine white plaster to conceal their humble material; this is the earliest use of wall plaster yet recorded.

THE mastery of the secret of burning lime for mortar and stucco was one step forward. The walls of this same White Room contain another: they were carefully oriented to the cardinal points of the compass, showing that the architect was able to command the services of an able astronomer or, more likely, was himself a learned man with some knowledge of the stars.

It is unlikely that this building was a temple. The numerous vessels of pottery and stone found in it indicate that it was used as a dwelling by many people. In the corner of one room was a small oven. In this was a cooking pot, its lid still in place. It contained the bones of the meat which was being cooked for dinner when the unknown enemy charged the walls and ended a civilization. Many years later the deserted mound was smoothed off by the conquerors or their descendants, who built the next city, Level 11, disclosed by recent excavations.

6000 years ago some housewife left this pot of lamb stew in the oven and ran for her life, never to return

In spite of the progressive architecture, there are constant reminders that we are dealing with an older city than modern science has known. For instance, metals have been left far behind; gold was found in Level 9, but its possessors were not acquainted with the processes of smelting and refining and working metals, but obtained them from metal-working tribes in the mountains. In what mountains? When we find out we will have taken a tremendous new step backward into the history of man's past.

The slender little vase for eye shadow which women used a long time prior to A.D. 1935

Commerce in these products and in others such as the rare lapis lazuli was carried on by barter; nearly 3500 years passed before coin was minted.

The study of the religions of primitive races begins with the study of their burial customs. Respect for the departed had not progressed, at Tepe Gawra in 4000 B.C., to the point where surviving relatives built large underground burial vaults, such as those of Level 9 already mentioned, to receive the wooden coffins of their lamented dead; but several large jars, painted in monochrome like other typical specimens of Level 12, have been discovered to contain the bones of infants. The bodies were not cremated but simply placed in jars and interred. How adults were buried remains to be learned; perhaps they were carried to a cemetery in the plain below the mound.

We do not know and we are likely never to know anything certain about the language of the painted pottery peoples. They were probably not acquainted with writing; it was a thousand years before the first groping pictographs were made at Ur, and the inhabitants of Level 12 of Tepe Gawra, at least, left no written documents. We shall never know even their name for the city.

IN the course of further research we must eventually discover the region of the earth's surface whence came the people who built the first primitive settlement known only as Tepe Gawra 20. Then we may be able to follow the wanderings and eventual fortunes of their relatives who migrated to other fields; and so we may come to know their racial and linguistic stocks. From other analogies it seems likely that they were associated with the Mongoloid or Circassian peoples; all conclusions along this line will contribute toward a solution of the still vexing problem of the origin of the Sumerians and their disputed relationship with the painted pottery peoples. Just so, do we hope some day to learn the identity of the strange invaders who wiped out Level 12 in turn and supplanted it with another culture.

Level 12 has produced none of the flat seals which are common in later strata at most Mesopotamian sites, but of such seals two impressions came to light, made on wet clay which was then baked into a record beyond time's power to destroy.

If we compare them with seal impressions found in Level 11 they are disappointing; among the latter is one which seems to show the earliest brewery (two men stirring the contents of a vat with long poles) and a number show ably carved naturalistic sheep and other animals.

These seals were used to consecrate,

Seal impressions found in level 11, one showing human figures, and the other the horned heads of rams

that is, identify, property. Their designs were, in effect, monograms of their owners. From inconspicuous finds important deductions can often be made. If individuals had property, the Tepe Gawrans were not communistic nor, at the other political extreme, did all the property belong to one ruling noble. Again, if an enemy destroyed the town to take its fields, we may guess that 6000 years ago mankind had already felt the pinch of hunger.

The presence of even primitive seals is very encouraging; frequently they carry religious scenes of these people, or record incidents in the phantom lives of their mythological heroes. By these means it is often possible to follow the thin thread of racial tradition where the absence of written records leaves no other clue.

No matter what vast gaps remain when Tepe Gawra has been dug and we have learned all the history its 20 cities contain, we know already that the same essential story of humanity will come out. The first find made in Level 13, at the edge of the mound where an impetuous Kurdish workman sank his pick below the floors of 12, was a slender little vase. It once held the kohl with which some far-away beauty darkened her eyelids against her lover's visit.

A LINK IN A CHAIN OF

Wheeler Dam . . . Completed Next Year . . . Will Produce Power . . . Has Navigation Lock . . . Operated With Other Dams, Will Control Tennessee River

By HERBERT F. GOUGH

WHEELER DAM, on the Tennessee River in northwestern Alabama, is the second major construction project now being carried out by the Tennessee Valley Authority. It forms one of the major links in the Authority's integrated program for the development of the water resources of the Tennessee River basin.

The Act of Congress in 1933 creating the Tennessee Valley Authority has granted broad powers for the fulfillment of a project, the first of its kind in American history, calling for the complete development of an entire watershed. Next to the soil, the most important resource of a region is its water, whether in the form of rainfall or rivers. In a steeply rolling terrain, however, a heavy rainfall may become a danger as well as an asset, and such has been the story of the Tennessee River watershed. A mean annual rainfall of 51.2 inches, about 145 billion tons of water, takes its toll of the river valley annually to the extent of about 2,000,000 dollars in flood damages. Furthermore, the river has carried downstream untold millions of tons of eroded soil during these seasonal fluctuations, building up sandbars and reducing the river's effectiveness as a navigable water-way.

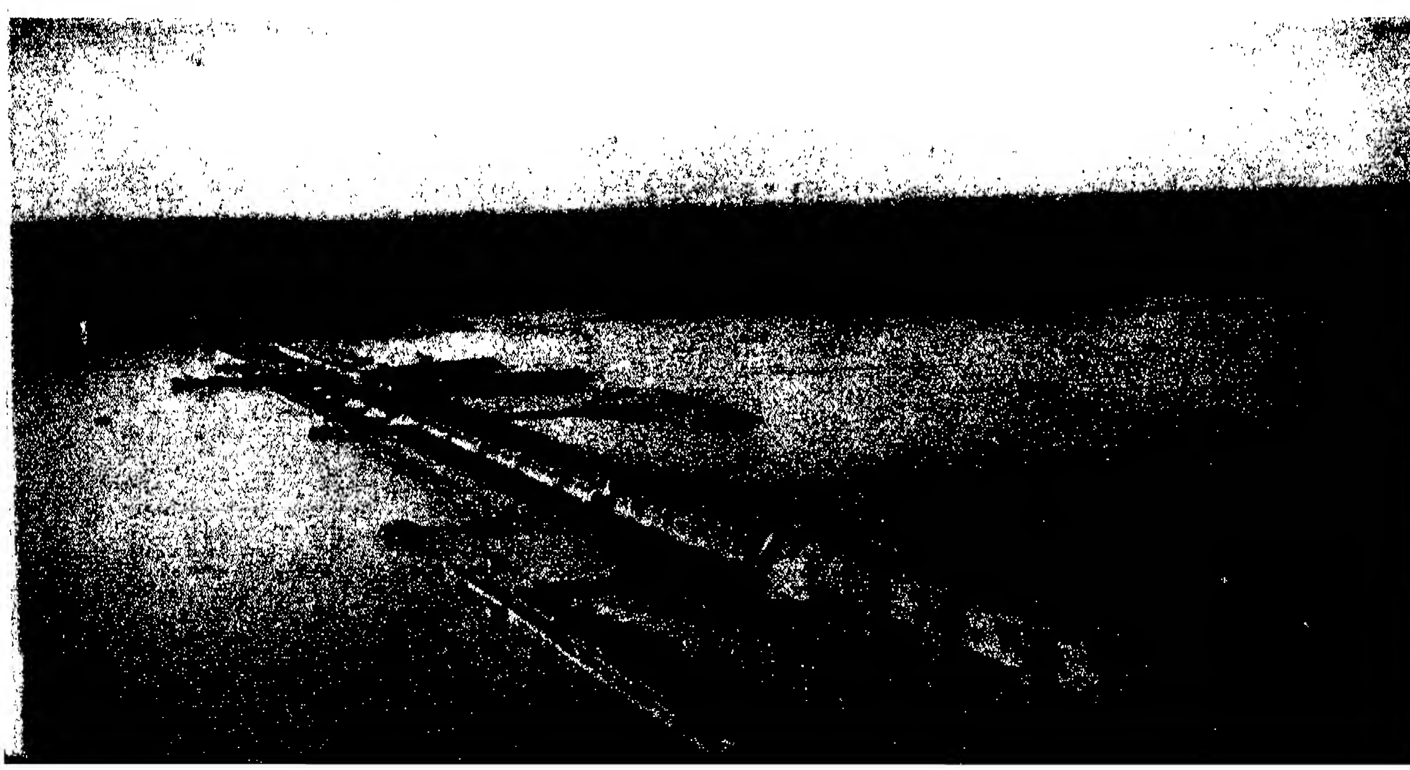
THE Authority's answer to these problems is a two-way control program. On the one hand it checks erosion at the headwaters through forestation measures, and on the other, it controls the river itself through an integrated system of storage and run-of-river dams. Storage dams on the large tributaries, such as Norris Dam on the Clinch, will hold back the run-off during the rainy season, thus leveling the flow of the river for navigation and flood control. Run-of-river dams, such as Wilson Dam and Wheeler Dam, in the Muscle Shoals area, graduate the flow of the main stream through a series of long narrow lakes which further reduce flood dangers and are useful for water-borne traffic. From Knoxville, Tennessee, to Paducah, Kentucky, the Tennessee drops 505 feet; narrow stretches of deep water connected by navigation locks will carry river traffic down a gigantic stairway 650 miles in length. Wheeler Lake, one of the steps in this stairway, will be 88 miles long.

Wheeler Dam, named for General Joseph Wheeler, Confederate general and a commander of United States forces in the Spanish-American War, was originally Dam No. 3 in the United States Army Engineers' survey of the power and navigation resources of the Tennessee River. Prominent in the War Department's recommendations during the past concerning this inland waterway is the development of Muscle Shoals.

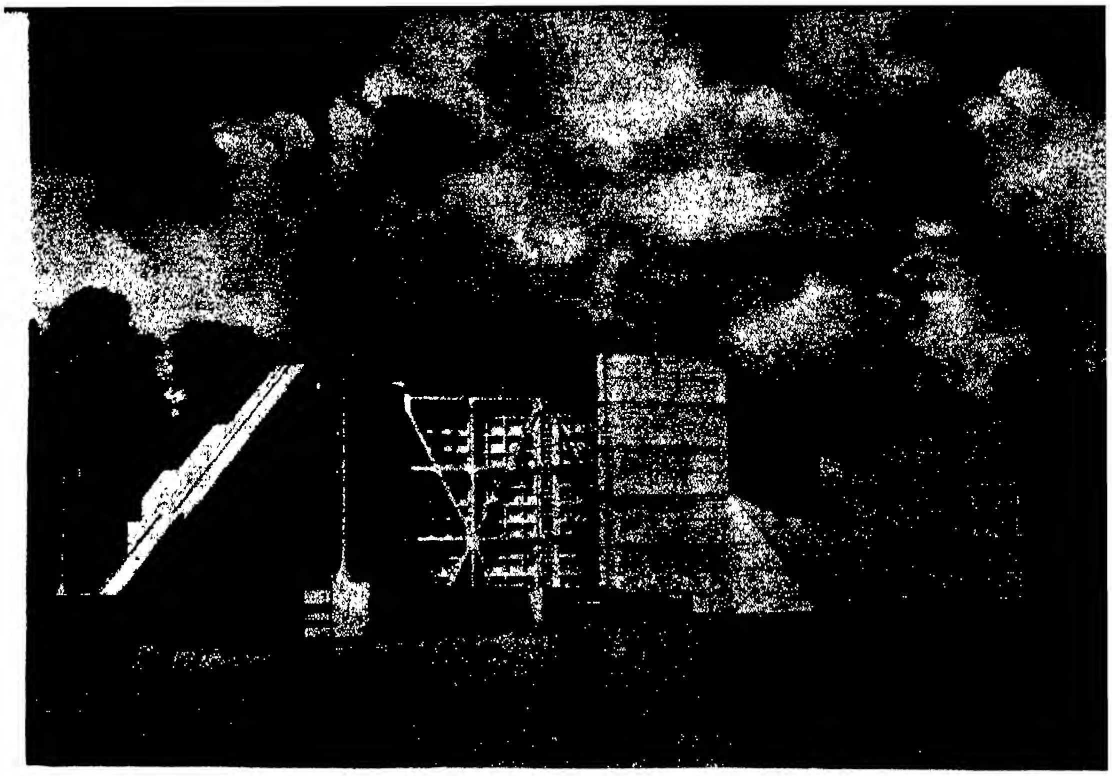
The Muscle Shoals area in the Tennessee River is one of the nation's great hydro-electric power sites. From Brown's Island, a few miles west of Decatur, Alabama, the Tennessee River forms a series of rapids over what the geologists term the Cincinnati Anticline. The greatest fall in this series of rapids, extending over approximately 37 miles of river bed, is 134 feet, only 33 feet less than Niagara Falls.

Wilson Dam, completed in 1925, while taking advantage of the power possibilities at the lower end of the Shoals area, eliminated 16 miles of the rapids as a menace to navigation. This factor largely determined the location of

Wheeler Dam in June 1935. The navigation lock is on the opposite side of the Tennessee River



DAMS



One end of the navigation lock, among the highest single-lift locks anywhere in the United States

Wheeler Dam, at the upper end of Wilson Lake.

When completed, Wheeler Dam will be a gravity concrete structure 6,335.5 feet—more than a mile in length—across the Tennessee River. This is 1340 feet longer than the great Dnieper River hydro-electric project in Russia. Beginning at the south bank, this huge barrier will be made up successively of a non-overflow section 157 feet long, 613 feet of power house, another non-overflow section 715.5 feet long, 2700 feet of spillway, 1756 feet of non-overflow, 159 feet of navigation lock, and a non-overflow section 235 feet long which will tie into the north bank. The non-overflow section is 55 feet wide at the base and 70 feet high. An inspection gallery, six feet wide by eight feet high, extends throughout the length of the dam.

THE spillway section of the dam will be 54 feet high, and 124 feet wide at the base, including the apron. The toe of the apron, approximately 24 feet below the river bed, will have concrete dissipators to break the force of the water flowing into the stilling pool below the spillway. End training walls, five feet thick, will rise 12 feet above the pool, while ten intermediate training walls will just reach the water surface below the dam. The spillway is divided into 60 bays, each bay being surmounted with a radial gate 15 feet high and 40 feet long.

Reinforced concrete piers will support a 20-foot roadway along the crest of the dam. A rising grade in the approach to the navigation lock, reaching a clearance of 57 feet over the reservoir pool level, will permit the uninterrupted flow of highway traffic across lock and dam without interfering with the passage of river boats through the lock.

The Wheeler power house will be of the outdoor type, with no housing over the crane or the generating units. It is planned for an ultimate installation of eight main generating units, having a total capacity of 288,000 kilowatts.

The generators will be protected from the weather by metal covers. The initial power house construction will consist of foundations for two units and complete installation of one 45,000 horsepower propeller type turbine, generator, and the necessary auxiliary equipment.

The dam will create a reservoir 88 river miles long with an average width of 1.3 miles. It will be 73,500 acres in area, or about 115 square miles, at an elevation of 555 feet above sea level. This will be the normal level of the lake.

Construction work commenced on the Wheeler Dam navigation lock under the supervision of the Corps of Engineers of the United States Army in December, 1932. The original plans provided for a 60-foot by 360-foot lock with a 37-foot lift, but the Tennessee Valley Authority arranged for the lift to be increased to 50 feet. The lock, now completed, is one of the highest single-lift locks in the United States.

In October, 1933, surveys of the site and preliminary plans for the dam prepared by the Army Engineers were turned over by the Authority to the engineering staff of the Bureau of Reclamation for preparation of a final design.

By the latter part of November, 1933, much of the preliminary work was well under way. The construction camp, commissary facilities, warehouses, and office buildings were erected. The approach roadway to the site was graded and culverts installed. The bridge over Big Nance Creek was strengthened. A 17-mile, 14,000-volt transmission line was built from Wilson Dam to the new project to serve the construction equipment. An arrangement was effected by the Authority with the Corps of Engineers of the United States Army for the lease of seven barges, three derrick boats, a dipper dredge boat, a Diesel-electric powered tow boat, a smaller tow boat of the pusher type, two small launches, and a fuel barge to handle its transportation requirements.

Actual work on the dam itself began on November 27, 1933, at which time the first crib of the first-stage cofferdam was erected. This first cofferdam, five of which are necessary for the diversion of the stream during construction operations, is approximately 1400 feet long and 400 feet wide, extending outward from the south bank of the river. It was made by confining an earth fill between two lines of wooden sheeting spaced 20 feet apart. Filling material for the wall was dredged on the north river bank, loaded on barges, towed across the river and unloaded into the wall with clam-shell buckets operated from derrick boats. The first cofferdam was completed and unwatered in January, 1934.

THE second cofferdam was started on February 19, 1934, with the building of two rock ramps to the top of the outer arm of cofferdam Number 1 from the river floor inside the cofferdam. The walls of cofferdam Number 2 were made of rock taken from the power house excavation, it being trucked up the ramp and dumped into the fill extending around the cofferdam. Afterward a blanket of clay was placed on the river side of the rock fill to make it watertight. This cofferdam was finished about August 1, 1934.

Cofferdams Numbers 3 and 4 followed according to schedule. Foundation excavation was finished in Number 3 during the latter part of June, 1935, and begun in Number 4 about the same time.

The damming of a river over a mile wide calls for a construction schedule adaptable to variations in the flow of water. This is the reason for the five cofferdams. Beginning with that on the south bank, which encloses the power-house site, their lengths are respectively 1425

Floating concrete mixing plants at Wheeler Dam. The gantry crane at the left swings the two-yard bucket of concrete into position and lowers it to the job

feet, 1238 feet, 1147 feet, 1100 feet, and 1004 feet. It is the intention to have only two adjacent cofferdams closed for any considerable time.

The dam, except that portion of the non-overflow section in cofferdams Numbers 4 and 5, will be built in alternate 15-foot and 30-foot wide blocks. As soon as the 30-foot blocks are built up to elevation 506, which is one foot above the level of Wilson Lake, the 15-foot blocks are built up above flood height, and the cofferdam may be removed and water diverted through the 30-foot openings. Water may also be diverted through the powerhouse intake tubes. During different stages of construction, flood water will be passed through various combinations of intake, 30-foot diversion openings, and whatever part of the river channel remains open.

A FORCE of 4000 men is working day and night in four six-hour shifts on Wheeler Dam. At the time of writing, practically 90 percent of the estimated 550,000 cubic yards of dolomite rock to be displaced has been removed from the foundation. As soon as each section of foundation is in readiness, a thorough job of low-pressure grouting is done with a neat cement grout. As soon as 10 feet of concrete has been placed, high-pressure grouting at approximately 150-pound pressure completes the job of sealing all cracks in the foundation for prevention of leakage or possible shear and sliding of foundation bedding planes.

Two thirds of the estimated 650,000 cubic yards of concrete to go into the structure have already been placed. In the power-house section most of the concreting has been completed. The 85-ton gantry crane to serve the intake gates has been erected. Erection of the 20-foot highway bridge structure along the crest of the dam is under way in several sections. Mass concrete is being placed almost continuously in spillway and non-overflowing sections.

All concreting materials reach the job by way of the Tennessee River. Some 15 miles below Wilson Dam, the floating equipment of the Cumberland River Sand Company is at work filling a contract calling for between 1,000,000 and 1,250,000 tons of sand and gravel. The aggregate is transported up the river in barges carrying about 400 tons each. The barges are tied up alongside the Authority's concrete-mixing barges.

The contract for cement at Wheeler Dam calls for delivery to the job in barges also. Members of the Authority's staff sample and test the cement before it leaves the plant. When it receives their recommendation, it is shipped by rail to Sheffield, Alabama, from which point it is transported by barge to the job.

Approximately 600,000 barrels of cement will be used in the construction of the dam. A "modified" Portland cement, having a heat rise somewhat less than a "normal" Portland cement, is used in all the work. This lower heat rise tends to cut down the expansion and contraction of the concrete during the setting and hardening process. The majority of the concrete being used gives a minimum strength of 3000 pounds per square inch at 28 days.

At the job all of this material—sand, gravel, and cement—is transferred to the TVA floating mixing plants, where it is combined in the proportions desired into concrete. There are four such floating plants.

Each plant is mounted on a steel barge 90 feet long, with a beam of 40 feet and 7 feet deep, specially designed and reinforced to sustain torsional stresses and all loads the mixing plants may impose. At one end of each barge is a whirling type crane with a 75-foot steel boom. It is designed for operation of a 2½-yard clam-shell bucket in transferring the aggregates from the river barge to the mixing plant bins. The 150-ton capacity aggregates bin occupies the other end of the barge. It is of steel construction, supported by a steel superstructure. Directly beneath the bin is the batching equipment which measures exactly the right proportions of materials going into each batch of concrete. On the deck beneath the batchers is the two-cubic yard concrete mixer. Between the aggregates bin structure and the crane stands the 500-barrel capacity cement bin.

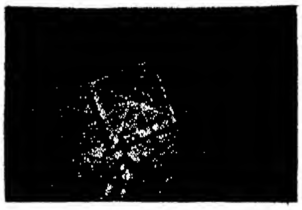
Each of the four mixing plants is capable of producing a two-yard batch of concrete in two minutes, 19 seconds. The mixer discharges into a two-yard bottom-dump bucket which is swung into position and lowered into the forms by an electric revolving crane equipped with a 95-foot steel boom. Several of these cranes, mounted on gantries, operate on wide-gage tracks along the length of the cofferdams as illustrated on this page.

WHILE work has been progressing at the dam site, operations have also been carried forward in the area to be inundated. In January, 1934, the 115 square miles of reservoir area was mapped from the air. Since the survey, over 3000 men have been at work clearing the tract of timber and brush. Though much of the reservoir land is under cultivation, between 20 and 30 thousand acres remain to be cleared by the Authority's forces.

It is expected that Wheeler Dam will be completed in the spring of 1936. From its operation there will be a by-product of hydro-electric power. This by-product electricity is not to be wasted, but will be made available to the residents of the Tennessee Valley and contiguous areas at "yardstick" prices.

Were Wheeler Dam operated for power purposes alone as a separate and distinct project, it would be at the mercy of seasonal flowage. Operated as a unit in a system of dams that eventually will control the flow of the entire stream, however, it is a highly valuable investment. And as the Authority's program develops, and more storage dams are erected on the headwaters, the value of the Wheeler investment rises in proportion.

2: Strontium nitrate 600X



3: Potass. bromide 600X

4: Potass. bichromate 600X

5: Potass. ferrocy. 150X

WATCHING CRYSTALS GROW

6: Potass. ferrocy. 600X

Under the Microscope . . . Perfect Specimens . . . Photomicrographs of Almost Any Chemical

By BENTON STONE, JR.

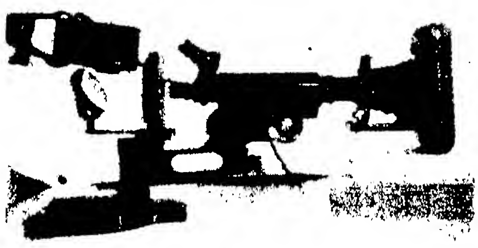


Figure 1: The set-up for the work

FEW things can be more fascinating than watching, under the microscope, very minute seed crystals grow as the solution reaches its saturation point. Gradually the water evaporates, leaving crystalline masses behind.

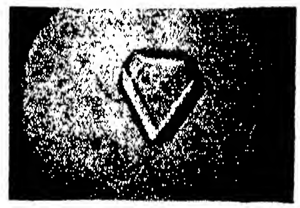
Permanent records may be obtained by the use of the camera in connection with the microscope. Almost any kind of camera will do. With large cameras the best way to make the exposure is by inclining the microscope to a horizontal position, as in Figure 1. The camera is set for a time exposure and focused at infinity. It is then placed with its lens against the eye-piece of the microscope and the exposure is made. Experimentation is the only means of determining the correct exposure. When used with a Kodak Vollenda with an $f/3.5$ lens, or any camera with a high-speed lens, snapshots of one half to one fifth of a second may be made.

Almost any chemical will form interesting crystals. The more slowly the crystals form the more perfect they will be. A very simple way to slow up the rate of concentration of the solution is to place a cover slip over the drop of solution. Usually from three to six hours is sufficient for the crystals to form.

To make a solution of the salt to be examined, place a small drop of water on a microscope slide; then, after dissolving a few crystals of the salt in it, set the slide aside until the crystals begin to form. When the solution begins crystallizing, watch for small seed crystals near the center.

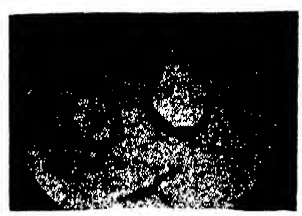
Some of the chemicals that are easily crystallized are: strontium nitrate, Figure 2; potassium bromide, Figure 3; potassium bichromate, Figure 4; potassium ferrocyanide, Figures 5 and 6; and chrome alum, Figure 7. The complex compound potassium mercuric-iodide will form the very beautiful crystals, seen in Figures 8 and 9. This compound is made by dissolving mercuric iodide in a solution of potassium iodide. Figures 10 and 11 show hexagonal crystals of lead iodide which was made by placing a small lump of lead acetate in a solution of potassium iodide. Cupric chloride, Figure 12, and magnesium sulfate, Figure 13, are excellent examples of needle crystals.

Crystals may also be obtained by sublimation of various salts. Most of these are ammonium salts. Place a little of the salt on a strip of metal and heat until it begins to vaporize. Then collect this vapor by holding a cool microscope slide in the fumes. If ammonium chloride is used, and not enough of the vaporized salt has been collected on the slide for crystals to form, the slide, when examined, will appear as in Figure 14. In this case, allow the slide to remain in the fumes longer and the crystals will form as in Figure 15.



7: Chrome alum 600X

8: Potass. merc.-iodide 600X



9: Potass. merc.-iodide 600X

10: Lead iodide 600X

11: Lead iodide 600X

15: Ammonium chloride 600X

14: Ammonium chloride 600X

13: Magnesium sulfate 150X

12: Cupric chloride 150X

WORLD ASTRONOMERS MEE

Every Three Years an International Body of Astronomers Meets, Mainly to Coordinate and Facilitate Cooperation of National Groups

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE meeting of the International Astronomical Union, in Paris, from which the writer is returning as these words are penned, was an unqualified success, and fully justified the long journeys necessary for its existence. If anyone might have doubted this it would have been the courteous and long-suffering press representatives who, inquiring day after day of the astronomers what news there was, met day after day with the response, "Oh, really nothing at all of general interest." But their disappointment arose, not from any lack of scientific activity, but from the very nature of the meeting itself. The Astronomical Union is definitely a working organization concerned deeply with actual investigation, but not at all with the announcement of its results. No great discoveries are made public at its meetings: indeed, it holds no sessions for the presentation of scientific papers, small or great; this is left to professional societies or academies of science. As in most other efficient bodies, the greater part of its work is done in committee—here, indeed, practically the whole.

There are more than 30 of these committees, dealing with subjects of all sorts, from the sending of astronomical telegrams to the internal constitution of the stars. Some have as few as five members, some more than 30, but in all cases membership is restricted to those who are working actively in the particular field.

MANY months before the meeting the chairman of each committee prepares a preliminary report and sends it by mail to the members—scattered, it may be, over three or four continents. From the replies, comments, and suggestions, he constructs a "draft report" which is sent to the general secretary of the Union, printed, and distributed to the members generally. These reports, for the Paris meeting, form a volume of more than 240 printed octavo pages.

Five working days, morning and afternoon, were devoted in Paris to the final sessions of the various committees. To adjust these so that no committee member was obliged to be in two places simultaneously must have been no small task, but it was accomplished with almost complete success. At these sessions the draft reports are discussed, bit by bit, not only by the committee members but by any other astronomers (for the meetings are open to all members of the Union), and put into final form, accompanied by such specific recommendations as are required. After this thorough-going and democratic preparation, all that remains at the subsequent "general assembly" of the Union as a whole is the formal acceptance of the reports and a specific consideration of requests for appropriation of money from the smallish funds which the Union has in its hands.

More than 30 nations belong to the Union, and 24 of these were actually represented at Paris. The French delegation was naturally the largest, with the British second. Next came the Americans—indefatigable travelers; then the Belgians; and so the list ran on to those small, remote countries which had but a single representative.

This disparity was not allowed to influence the Union's policies. The important special committees on finance, and on the personnel of the new committees, were composed of national delegates, one from each country. A somewhat similar scheme of voting by countries is provided, in event of a close decision at the general sessions, but no such differences of opinion arose this year. The chief practical inconvenience in working this well-designed scheme—and one which is unavoidable at a purely international gathering—is the old Curse of Babel. French and English were equally the official languages of the meeting but, alas, the number of astronomers who had really a mastery of both was all too small. Very few Frenchmen spoke English—a few or fewer Americans could manage with French. The Englishmen were a bit better, but honors fell, as always, to the Dutch and Scandinavians, practically all of whom were fluent in English and many in French as well.

Most of the delegates could read the other language almost as easily as their own. But only the painful attempt shows how far this reading knowledge is from the power to speak. Fortunately there were a few first-rate linguists who carried off admirably the difficult duties of interpreters. After every important speech in committee or in debate it was repeated in the other language, and the same was done for each motion before it was put. The writer recalls with gratitude the Belgian secretary of one committee—appointed despite his disclaimer of much knowledge of English—who, immediately after the conclusion of each man's remarks in a lively and technical discussion almost all in English, entered on his minutes an accurate and lucid abstract in French.

SO much for the machinery of the conferences—what of the results? These are naturally as varied as the subjects with which the committees deal. For example, that upon the constitution of the stars has always reminded the writer—who belongs to it—of the Scotsman's description of "four and twenty pipers each playin' his ain tune." Pioneering is not done according to rule. But the meeting of the committee, at which Sir Arthur Eddington, its chairman, called on half a dozen or more people who knew something about the subject for brief discussions of the present problems, was one of the high spots of the week.

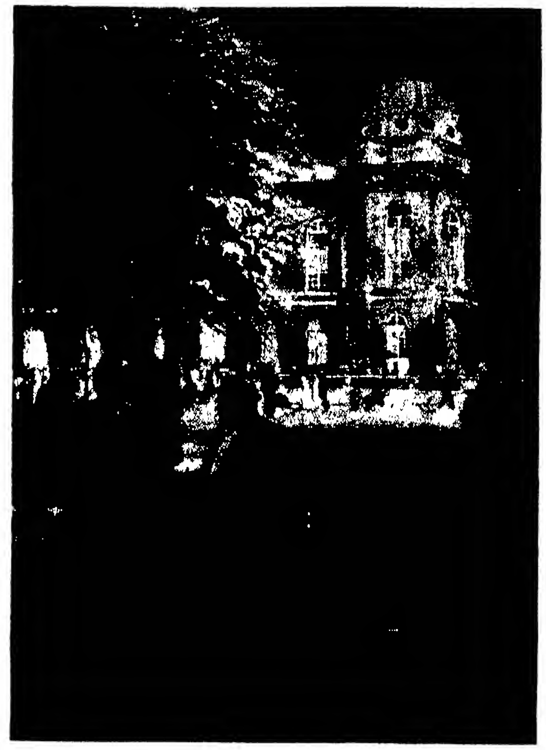
Some committees have laboriously worked out results which, when finally put into shape, are likely to remain standard for many years. The committee on standard wavelengths, for example, gives tables of lines of neon and krypton, measured with the greatest care by three or four different observers in various countries, for which the extreme range of difference among the results averages less than one part in 10,000,000, and discusses the details of laboratory technique necessary to secure an accuracy of one part in 50,000,000! Others, with no less labor, must deal with a human element. The

AGAIN

committee on notations and units presented a list ten pages long of proposed symbols for the quantities which are most often used in astronomical discussions. Some of them are already almost everywhere in use, such as z for the zenith distance of a star—alpha (α) for its right ascension. For others, various investigators have used quite different letters, to the great discomfiture of the student who tries to compare one paper with another. After discussion of a number of details, the committee voted to recommend the list for publication as a preliminary set of suggestions, inviting anyone who advocated changes or improvements to write to the chairman, in the hope that at the meeting three years hence some definitive list might be recommended—not, of course, imposed on anyone by compulsion, for the Union has no such authority. One chairman at least will probably be kept busy!

PERHAPS the knottiest problem that anyone had to consider was the terms used to describe our time reckoning. Before 1925, astronomers counted the hours of the day from noon (so that the local time was identical with the sun's hour angle), while the day began by civil reckoning at midnight, 12 hours before. It was internationally agreed ten years ago that the astronomical reckoning, too, should in future be made from midnight. No confusion would arise if the new time reckoning had a new name and, outside of England, it was usually called Civil time, while astronomical mean time was counted from noon. The abbreviations G M T, for Greenwich Mean Time, and G C T, for Greenwich Civil Time, have been used ever since in the American Ephemeris. But—so gossip has it—when these letters came to the attention of a distinguished British admiral, he remarked, "This won't do at all—G C T is Gunnery Control Tower." Be this as it may, admiralty orders appeared compelling the British nautical almanac to use G M T to denote time counted from midnight. To add to the tangle, it appeared that, under English law, "civil time" denotes the reckoning established by Act of Parliament, so that when "summer time" was thus adopted for daylight saving, this and only this could lawfully be called civil time!

Now Greenwich time has long been used as a base for general international reckoning. Before these complications arose it had been suggested in Germany that time according to this reckoning be called *Weltzeit* (W Z)—that is, world time, while a French suggestion was U T, which in French or English stands for Universal Time. Both expressions mean exactly the same as "Greenwich mean time counted from midnight," neither of them has yet been used to mean anything else. One or the other of these (or very likely both, W Z being the German translation of U T) is likely to be generally adopted to clear up the muddle. The writer regrets a little that the new phrase is not "world time," but the French symbol has clear priority and may therefore be adopted, though it reminds one a little of the beauty contest promoters who propose, after selecting "Miss Europe" and "Miss America," to decide which of the two deserves the final honor of being "Miss Universe." But the White Knight was right when he told Alice-through-the-looking-glass, "What a thing is, and what is its name, and what it is called, are all quite different."



An evening party at the Observatory of Paris, in honor of the International Astronomical Union. Drawing by J. Simont, in *L'Illustration*

NO less valuable than the formal meetings were the informal discussions in between. The writer, for example, is much indebted to Dr. Antoniadi of the Paris Observatory for his details of his observations of Mercury with the great telescope at Meudon. In agreement with others, he finds that the planet keeps the same face toward the sun, and exhibits darkish patches somewhat like those on the moon as seen with the naked eye. These markings are permanent, but at times he has found one or another to be "obscured" and practically invisible. He explains this by the presence of a thin atmosphere—too little to produce twilight effects but enough to stir up at times clouds of dust which veil the surface. While it is not certain that this is the only explanation, these reports by one of the most skilled of planetary observers leave the question of Mercury's atmosphere open again. Though the planet certainly could not retain the lighter gases, there appears to be no conclusive reason why it might not have some atmosphere composed of heavy molecules such as carbon dioxide or denser gases. Adams and Dunham have detected no spectroscopic evidence of atmosphere, but an amount much too small to pass this test would suffice.

To return to the Astronomical Union: A New Committee on Comets was formed, and an old and inactive one on Lunar Nomenclature was revived as a general committee on the moon dealing both with its physical characteristics and with the theory of its motion and the observation of occultations. Professor Baldet, the discoverer of the characteristic "comet tail" spectral bands, is an appropriate chairman of the first, and Professor Brown, known to all men for his lunar theory, of the second.

An invitation to hold the next meeting of the Union in Stockholm was enthusiastically accepted, and only the election of officers remained. Dr. Esclangon, Director of the Paris Observatory and our principal host during the meetings, was elected president. Among the vice-presidents are Adams of Mount Wilson and Spencer Jones, the Astronomer Royal. Dr. Oort of Holland is the new General Secretary.

The social side—always a pleasant part of the international meetings—was unusually so this time. A long series of receptions, excursions, and dinners culminated in a banquet on July 14th upon the Eiffel Tower, whence the brilliant illuminations and fireworks of the national holiday made a splendid spectacle, and in a reception by the President of the Republic, who thus showed most gracefully his interest both in science and in international good will. Deep appreciation of the cordiality of our reception, no less than of the success of our scientific work, forms the final impression of the conference.—*At sea, M. V. Georgic, August 2, 1935.*

Nature Faking Again

Silly Stories and Pictures to the Contrary Notwithstanding . . . Quite Unthinkable . . . Often Laughable . . . Nonsense . . . Fancy Yarns

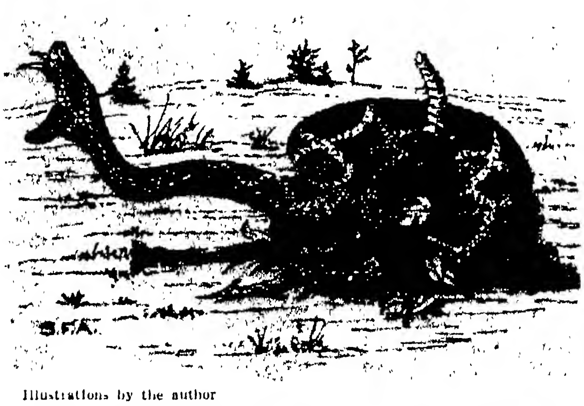
By S. F. AARON

EXAGGERATED wild yarns by observers who are not only to be respected for their love of nature but also for their delightful portrayals, are far too many in number and importantly presented. As such, these observers do much more harm than the spinners of wilder stories who should confess to entire ignorance. It is not altogether surprising that palpable nature fakers find opportunity to get into print, for they tell much that is faithfully illuminating. Generally the editors of literary and popular periodicals and books know even less about these things than the writers, and thus they accept without question many remarkable stories, and brag about the writers to boot. In most cases a boot should be applied somewhere.[1]

Recently we have seen the remarkable assertion, on the part of the editor of a leading magazine, that the author of a certain nature yarn was the best informed upon his subject among naturalists anywhere. A fine compliment, this, to the scores of capable investigators! It followed the telling, by the boasted and boosted one, about a horse which feared the odor of a rattlesnake (which is a direct untruth), and it even referred to the maker of mud-dauber wasp cells as being of the masculine gender!

Many of our recent nature narrative writers who have sought to emulate White of Selborne, Burroughs, Thoreau, and especially Seton, have floundered, sometimes badly, in the quagmire of lack logic. Seton himself, remarkable for his wide knowledge, was not altogether free from small errors, as when he made Wully, the dog, close the window through which he returned after a sheep-killing foray. No canine will close a window nor a door after entering, unless especially trained with much care. Marvelous ferocity is also ascribed to the fisher, listing among its victims the fox, badger, beaver and even the otter and bobcat. Much of this will not hold water, for some of these creatures could not be overtaken if they chose to retreat, while others are too powerful for the fisher.

It should be well known that, however savage and blood-thirsty any killer may be, whether cat, wolf, bear, or of the weasel family, there is always uppermost a distinct respect for others of like nature and anywhere near the same size, for the severe wounds given in a contest are disabling, and no hunting mammal can well afford to be thus handicapped, even though it is sure of getting the better of the scrap in the end. Thus the puma and the bear respect each other, various silly stories and pictures to the contrary notwithstanding. The same may be said of the



Illustrations by the author

How a rattlesnake strikes: It requires a solid base—half or more of its body on the ground—to permit the forward one third to do its work effectively

puma and the big timber wolf, the fisher and otter, the wildcat and raccoon, the fox and mink, and the mink and weasel, all of which seek the course of least resistance even when tidbits may be a cause of envy between them, for a law of the wild that holds the captor or first possessor of food to be the rightful owner is generally obeyed.

Bloody warfare between killers and other creatures—often battles to the death which never occur even between rival lovers—is the most fruitful subject for nature narrative thrills, and it is an unusual book or article by any of the fakers that does not include some such incident, often one at least to each chapter. Thus we have our two wildcats meeting and fighting on general principles, and this is quite unthinkable. We have a badger and a coyote disputing for no worldly reason; and so on through the list of killers, even down to the tiny shrew which one of our nearly unlimited exaggerators calls "little death" in a chapter devoted to such remarkable adventures as the killing of a water snake by the brave insectivore.

Studies of the food habits of reptiles depict numerous shrews and mice being swallowed by water snakes, milk snakes, king snakes, young black and garter snakes, and even by the slow-moving spreading adder.

NATURE narratives are also noted for their superlatives galore: the strike of a rattlesnake is said to be "the swiftest motion in nature;" the heroic duck hawk "the speed king of the air;" the leap of a stag as the floating of thistledown; the tireless speed of a wolf as unequaled; the bloodthirstiness of a weasel as quite beyond compare—all these to be virtually contradicted later when other creatures are the chosen heroes. All of these statements are untrue.

These stories are often laughable, as for example the narratives of the delightful writer who is a member of scientific societies and whose works are always eagerly read. In one article he presents the peregrin falcon, *i. e.*, the American duck hawk, as the swiftest of all birds and doing unbelievable stunts in the air, in addition to its well-known swoop from on high. In another magazine he declares the northern gyrfalcon to be the swiftest of all birds, and in an account of a Mongol emperor's falconry he tells of two of these rival hawks swooping at each other in mid-air until one is killed, the description being such as to give the impression that by contact of the breast bone, or some such bomb-like influence, the victim was burst open. This is al-

[1]The author evidently believes that editors would prove to be reformable!—*Ed.*

most unworthy of comment; these hawks strike with their talons to rip and kill, and two of the same or allied species will not fight each other. Never more absurd yarn was written.

And this last-mentioned author also quite eclipses himself in writing for one of our leading fiction magazines about wildcats. The climax is reached by admitting the yarn of an old southern hunter, that one of his hounds killed a full-grown bay lynx by gripping its chest and bearing down upon it. Now, imagine a hound's force shutting off the vitality of a creature that sometimes survives for a time the crushing weight of a dead-fall. What would the eyes, ears, jowls, tender nose, neck, and belly of that hound resemble after the cat's awful claws had been busy for a few seconds? Is it not strange that faculties of observation sufficient to permit a fellow's becoming any kind of naturalist would not set him straight enough in a matter of this kind to avoid repeating such nonsense?

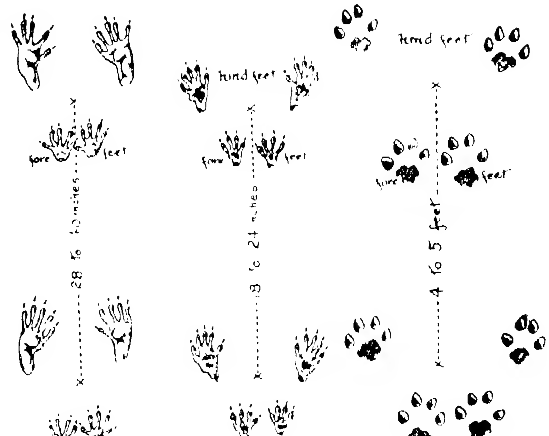
ERRORS due to ignorance are much too common in the form of assertions after quotations repeated from sources that are often unknown. The function of cocoons as a protection to the chrysalides "from cold" is as old as Drury and Westwood, but unfortunately the thickest and strongest and warmest cocoons are found in tropical countries where the bills of parrots are most powerful. Common sense should indicate that there is not enough heat within the insect body to withstand cold in any covering.

This leads to the common and oft-repeated impression that cold weather destroys insect life. As a matter of fact, it does nothing of the sort, but only suspends vitality, and the consequently inert insects that have not lived their natural lives are destroyed by their enemies.

The statement is also made that cold weather is fatal to reptiles—this in a nature narrative by an exceedingly presuming nature student. But the finding of snakes wintering under shallow stones, frozen stiff but easily revived by warmth; also the existence of salamanders and frogs under similar conditions, proves the contrary.

Ephemera or day-flies are commonly believed to live only 24 hours but many species that do not immediately mate and lay their eggs after leaving the pupal form in the water survive for more than two weeks.

It is more than amusing to read of venomous snakes leaping at their enemies or prey; a score of writers have so stated. But naturalists well know that no snake can strike more than one half its length, and that snakes rarely attempt to reach more than one third. Then we have the common impression that the bite of poisonous reptiles is always fatal, and this has been the backbone of more than one fancy story. Records prove that about one such bite in 20 is fatal.



The rapid running tracks of the raccoon (left), gray squirrel (center) and bobcat (right) are evidence that the hind feet overlap the others

THE speed of snakes, especially the black snake and racers and the western coach-whip, is often ridiculously exaggerated. Even that great naturalist and paleontologist, Edward D. Cope, was once misled regarding this matter, but by test it has been proved that no snake can travel faster, under any conditions, than a person can walk.

Repeated attention must be called to that oft-told and absurd yarn that infers hypnotizing powers possessed by the weasel. The little killer's motions are so swift, its fearlessness so marked, and its successes so common, that it is hardly more than natural for the fakers to capitalize upon these powers. We are not only led to suppose but we are indeed plainly informed that, when the weasel desires rabbit for dinner, it has merely to find Molly and almost calmly cut her throat with little or no protest on the part of the victim, who apparently knows the futility of trying to escape. Squirrels also come under the spell. How ridiculous indeed is the notion that any creature endowed with the primal desire for self-preservation should not practice it with extreme energy at all times![2] As a matter of fact, for every rabbit that is killed by weasel or mink a score of them escape and, were it not so, there would very soon be no rabbits. Every experienced field naturalist has witnessed Molly breaking away through briars and leaving the baffled killer behind, or by powerful kicking and leaping and superior speed saving her life.

With regard to this power of the mustelid killers, there is every reason, based on wide observation, to contradict the statement in "Wild Animals of North America," published by the *National Geographic Society*, that the comparative slow-going fisher captures snowshoe rabbits in fair chase, and squirrels without difficulty in the treetops, as also do martens.

IN the line of faking, because of the nature of the contribution, the limit of error has almost been reached in a popular periodical. Under a caption that infers that it is well not to let the world get ahead of the seeker for information, the statement is made that the greyhound, hare, and kangaroo are the only animals that hit the ground with the hind feet in front of the forefeet when running. All the active rodents, such as the squirrels, the kangaroo rat, many of the mice and lemmings, the woodchuck and whistler, the little chief hare, the raccoon, the mink, weasel and fisher, the wolves, cats, and the prong-horn antelope, and very probably the many deer species all the world over, so place their feet when in a hurry, and there is good evidence also that a running race horse does the same, though more irregularly. A paragraph in the same article states that there are yet *millions* of fish and insects still unclassified. This also is an absurdity; the exploring naturalists and collectors have brought from every part of the world nearly all kinds of plants and animals, and the systemists have named and placed them in their proper genera and species.


The weasel is a ferocious animal but is not capable of climbing as fast as a chicaree. On the ground the two are about equal in speed

[2] ***Editor's note:*** **As the author states, the idea of an animal abandoning the instinct of self-preservation surely is ridiculous. Even so, we once watched a cat on the ground, five feet from the base of a tree, and a squirrel ten feet above, each for some time steadily eyeing the other. Then we saw the squirrel trot quite slowly down the trunk and along the ground, not in some other direction but straight to the cat's jaws. The squirrel definitely went to the cat, which did not move. On the grounds advanced by the author this was indeed odd conduct. We do not claim that there was hypnotism, or that we understand it; we merely describe what happened.**

LIGHT WAVES IN INDUSTRY

Gage Blocks . . . Master Gage Blocks . . . Optical Flats . . . The Master Controls

By EVERETT W. MELSON
Bausch and Lomb Optical Company

ONE of the primary factors in our ability to turn out masses of products that are satisfactory in performance is the ability to create machinery of unusual accuracy. This accuracy has come about by methods of measurement which have cut the tolerances in machine tools to fractions undreamed of 50 years ago. In the production of machine tools few things are more necessary than precision gage blocks. A steel block about one inch in length is just a piece of steel, but with proper heat treatment, extremely refined lapping, and measuring processes, it may be finished until the length is definitely known to be one inch within a limit of one-millionth. This is a gage block. Without such an instrument, manufacturing in mass on a basis of interchangeable parts would be impossible.

It must be apparent that, behind the ordinary measuring tools and gages used by the machinist in controlling everyday production, there are other and still more accurate measuring and checking devices for testing the accuracy of his tools. Since all tools inevitably wear, warp, or lose temper with use, the work controlled by each will vary to such an extent that parts will not interchange and mass production becomes impossible, unless their precision is restored. Accordingly, in most large industries there is an inspection department, headed by a chief inspector, who has under him foremen inspectors for the various departments.

IN metal working, the chief inspector is usually a trained metallurgist acquainted with the materials of machine construction, testing of materials, and the hardening and tempering of steel. It is necessary for him to know that brass or bronze, for example, will stretch, and that holes reamed or drilled in these materials are usually smaller than holes made with the same tools in cast iron. He must know that tools used in machining aluminum require more rake, or cutting angle, than is used for steel because aluminum is lighter and more ductile. Inspections are dependent on the nature of the material being worked and the tolerance permitted. In working some of the nonferrous metals with a tough texture and a peculiar flow, an inspection of tools may be required after every operation. Daily inspections are necessary on many screw thread jobs, but weekly and monthly inspections suffice in many industries.

As the life of machine parts is determined by the kind of metal on which they have to work, so the life of gages is determined by the metal in the machine parts. Cast iron, because of the presence of crystals of cementite or carbide of iron in the metal, is likely to wear the surfaces of a gage at the rate of 0.00025 inch for about 10,000 parts inspected. Aluminum, containing alumina or aluminum oxide in crystalline form, may be expected to wear a gage 0.00025 inch for 11,000 parts tested. In steel the lapping effect is not so great and a gage may inspect 30,000 parts before losing its tolerance.

Ordinarily four sets of gages are used for inspection work on machine parts—master, checking, working, and tolerance. Master gage blocks, themselves accurate within five millionths of an inch for the small ones, are checked against still more accurate pieces of glass or quartz, worked so nearly to a perfect flat that if the surfaces were extended for 75 miles they would deviate not more than an inch from a straight line at the terminus. Thus gage blocks and optical flats are the master controls of modern mass production, to which all tools are referred in final analysis. Small as they are, their significance to industry is large.

As difficult as is the mechanical achievement of securing accurate flatness and parallelism in the surfaces of such blocks, the problem increases in difficulty when it is necessary to attain, in addition to the flat, parallel surfaces, a given length within one millionth of an inch. The process is still further

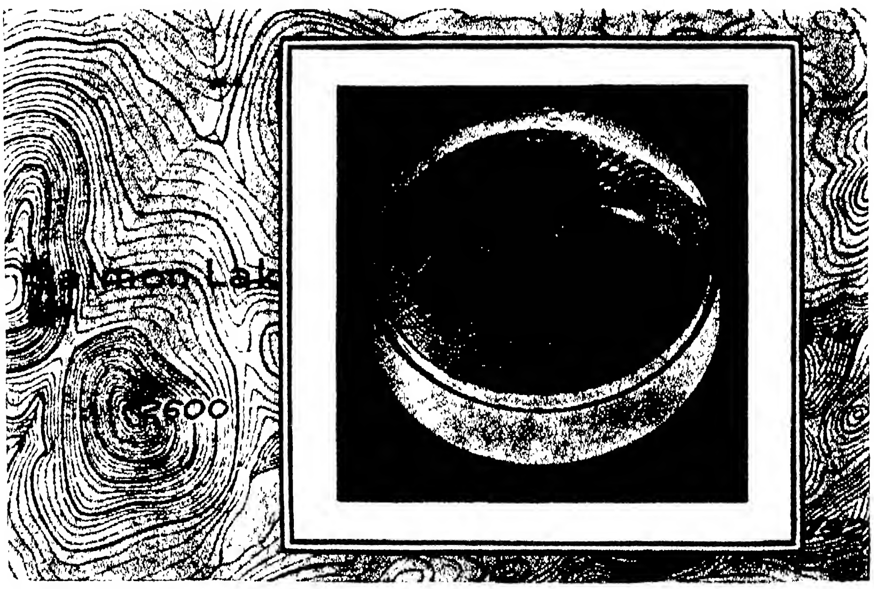


Figure 1: **Interference fringes between a flat and a surface which is about 20 fringes (equalling 10 wavelengths, or 1/5000 inch) curved, and irregular. The fringes are interpreted precisely like contour lines on a topographic map, the "contour interval" being one half wavelength, or about 1/100,000 inch**

complicated when a complete series of blocks must be produced by progressive increases in size, or increments of one ten-thousandth inch.

Since the kind of steel used in a gage block has much to do with the final success of the work, extreme care must be exercised in its selection. Many experiments have been made by the Bureau of Standards and gage manufacturers to determine the formula that offered the important qualities of permanence and stability. Carbon steel and chromium steel have proved most satisfactory.

As durability and permanence are important factors in making gage blocks, the heat treating process is an important and critical operation. The smallest variations in condition or structure may ruin the blocks. The stabilizing treatment must be controlled within a narrow range of temperature, as this process is largely responsible for the permanence of the finished gages.

Owing to thermal expansion, material standards of length can be correct to their nominal sizes only at one particular temperature. Therefore, in machining parts to accurate dimensions it must be determined at what temperature the sizes shall agree with the figures specified. The measuring instruments are adjusted to suit that temperature, commonly known as the standard temperature, or temperature of adjustment. In America, 68 degrees, Fahrenheit, is the standard in general practice in the engineering industries. While it is impossible to avoid some contraction and expansion in the blocks with changes of temperature, once a block is made to a predetermined size at a fixed temperature, it will usually return to that size when subjected to the original temperature.

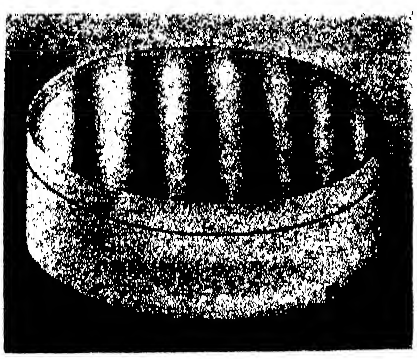


Figure 2: **Straight fringes—the upper and lower disks are flat to at least a millionth of an inch**

No matter how accurate a precision gage block may be to begin with, it is useless as a standard unless it retains its original accuracy. Changes which ordinarily would be unimportant are very serious in blocks made to obtain a range of dimensions varying by only 0.0001 inch. Here, errors of a few millionths of an inch cannot be tolerated.

And now the question is, how do we know that these gages are correct to within one millionth of an inch?

Most of us have noticed the iridescence in a drop of oil floating on water. The tiny rainbows that appear are due to light wave interference. When light waves strike a surface they are reflected, and when two surfaces are close together, such as the top and bottom of an oil film, light waves are reflected from both surfaces; but because the distance is greater to the second surface, the reflections interfere, producing bands of colour instead of white light. These are called Newton's rings.

Light waves possess all the necessary properties of fundamental units of length, the most important of which are constancy, reproducibility, accuracy of measurement and ease of application. Because they vary in length, different color sensations are received by the eye. When two trains of waves from one point in a source, having traveled different paths, fall upon a point on the retina, the resultant amplitude of vibration determines the brightness. If they are "in step" maximum brightness results. But if the troughs of one arrive with the crests of the other, destructive interference takes place, resulting in darkness. If the two trains travel different distances, so that the difference in path is some whole number of wavelengths, then the waves will reach the eye in phase.

Figure 3: **A gage block between a pair of flats, for testing a part**

By the use of optical flats, light waves are utilized in testing plane surfaces. If we take two perfectly flat pieces of glass, or preferably quartz, and lay one upon the other, touching at one edge but slightly separated at the other, a wedge-shaped space will be left between them. If the surface being tested is irregular, the pattern produced by interference assumes the appearance of a contour map, as shown in Figure 1. The position and number of bands or "fringes" shows the exact location and characteristics of the surface irregularities. If the surfaces are absolutely flat, alternately colored bands will appear—parallel and straight (Figure 2). The distances between the surfaces at the first dark band is approximately half of a wavelength or one one-hundred thousandth of an inch; at the second, two one-hundred thousandths; and so on.

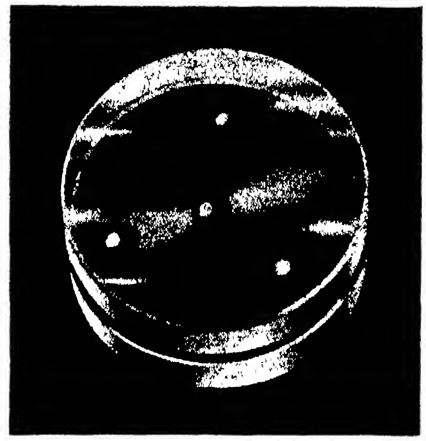


Figure 4: **This is not an optical test but a purely mechanical one**

With light waves it is as easy to measure in units of hundred-thousandths of an inch as it is to measure in thousandths of an inch with a machinist's micrometer caliper, but the accuracy of light waves, measured with the same degree of care and skill, is a hundred times greater than the micrometer. Furthermore, as the experienced machinist estimates tenths of graduations with a micrometer, the user of light waves estimates in millionths of an inch by a kind of interpolation.

In the comparison of a precise part, having plane surfaces, and a standard gage block, two optical flats are used. The part and the gage block are wrung on to the lower flat with a twisting pressure of the hands and the upper flat is held securely touching the top of both the part and the gage, shown in Figure 3. From the position, direction, and spacing of the lines, the exact amount that the part differs from the standard can be determined in millionths of an inch. In sodium light the presence of each Newton ring discloses a separation of half a wavelength, equal to 12 millionths of an inch.

The adherence which can be obtained between two gage surfaces through the feature of "wringing" is itself an excellent criterion of their flatness. A general curvature amounting to more than 0.00001 or 0.00002 inch at the center of the surfaces is sufficient to affect materially the tightness of the wring, unless the curvatures of the two surfaces tend to match. It is possible to wring together a number or train of gages with a combined twisting and sliding

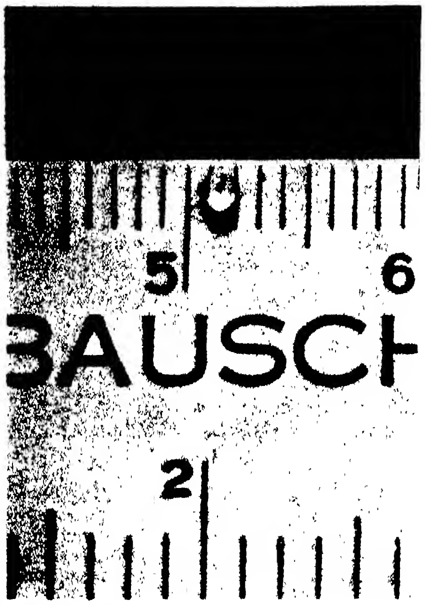


Figure 5: **A tiny lens, worked to a precision of a millionth inch**

motion. When brought together in such a manner, it is found that the gages adhere strongly and thus form a single gage whose length is the sum of the component gages. The adherence is due almost entirely to the presence of a liquid film between the faces. This can be shown by carefully cleaning two gages with alcohol or ether, after which no appreciable wringing effect can be obtained. But the mere touch of the fingers or hand deposits enough moisture or grease to restore the wringing effect.

Although the presence of a liquid film is practically essential for cohesion to take place between the gages, the thickness of the film is very minute if the gages are properly wrung. A large number of measurements show that when two very plane surfaces are brought into contact in this manner the separating film is not more than one millionth of an inch thick. If the gages have a high optical finish more intimate contact is possible, because the capillary film is thinner. Then the required separating force may range from 95 to 100 pounds per square inch. Gages with less than half a square inch of surface area have been known to sustain a separating force of 220 pounds.

THE closest approach to ideal flatness and smoothness of surface is achieved in the high quality optical flat. It is very dangerous to allow such surfaces to come into intimate contact, since the molecular attraction across the interface approaches that across a plane through the solid glass and the flats tend to become one solid block. That such a tendency does exist is shown by the fact that efforts to separate two optical flats which have been firmly wrung together almost invariably results in partial destruction of their surfaces, small pieces of glass being pulled out of each face by adhesion to the opposite surface.

In addition to plane surfaces, the diameter of a ball or cylinder may be easily measured in comparison with a gage-block. Steel balls are frequently used in tool rooms and inspection departments as standards for testing micrometers and for gaging cylindrical and taper holes. Periodical measurements of steel balls have shown a marked tendency toward shrinkage to occur with age. This necessitates re-standardization at frequent intervals. One method of doing this is to place a gage block, and the ball to be measured, between two optical flats. The ball serves as a taper gage, with the dark interference bands as graduations of .00001 inch. With only two flat surfaces and a gage block standard, any piece that is ordinarily measured between the flat surfaces of a micrometer or measuring machine may be easily and accurately measured with light waves. Another way is to choose three balls by comparison with gage blocks. These are placed equidistant around an improvised retainer and held between the flats (Figure 4). A larger hole in the center of the retainer holds the ball to be tested for size. Moving the top optical flat will cause the three outside balls to move if the center one is too small, but if the outside balls fail to move the center ball is too large.

The extreme precision secured with light waves may be illustrated by an apparatus consisting of a solid steel bar five inches in diameter with end supports 36 inches apart. A gage attached to the bar, and an optical flat fastened to the channel iron structure above the bar, serve to set up interference bands. A slight downward pressure of the fingers on the bar causes the gage to move away from the optical flat and the bands to move. It is very easy to bend the bar with the fingers to show a movement of the bands two or three times the distance between successive bands, or two or three hundred-thousandths of an inch.

In measuring with light waves it is convenient to reckon in millionths of an inch or tenths of a unit indicated by each dark band. Thus the hundred-thousandth of an inch is ten millionths; the ten-thousandth is hundred millionths and the thousandth is thousand millionths. Such a small unit of measurement is hard to conceive. It may be understood better perhaps by knowing that a half inch steel bar projecting twelve inches from a vise is bent downward approximately one millionth of an inch when a common house fly alights on the end of the bar.

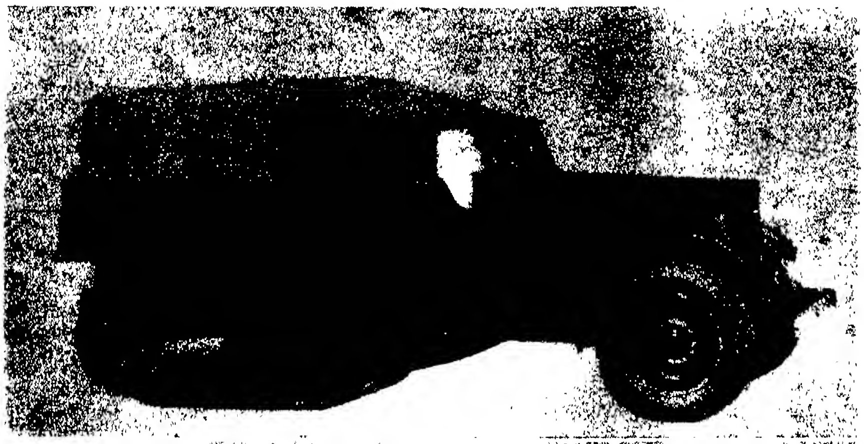
THERE are many possible applications of light waves to industrial requirements and for scientific research. In the largest optical institution in America, scientists bend light with utmost precision in lenses and prisms. In the precise work of making prisms for military range finders, lenses for large telescopes and high power microscopes, such a slight irregularity as a millionth of an inch is a serious matter. The right angles of prisms, whose sides are about an inch long, are machined to within one second of arc: that is to say, were the sides of the prism to be extended, the error from the right angle would be less than a foot at a distance of 43 miles.

In the group of roof prisms shown in Figure 6 is a very small prism with four polished and two ground faces, the largest dimension of which is about one-eighth of an inch. The angles are within ten seconds of the specified values. In Figure 5 the front lens of a microscope objective is shown. This little hemisphere is but three hundredths of an inch in diameter but is accurate in dimensions to ten-thousandths, while the surface errors are reduced to millionths of an inch.

In hundreds of plants where interchangeable parts are made by the thousands and millions, light waves are the court of last resort in determining whether a machine tool is meeting the specifications required. Back of all the complicated machinery that whirs in industry are a few small bits of flat surfaced glass that keep it on its course.

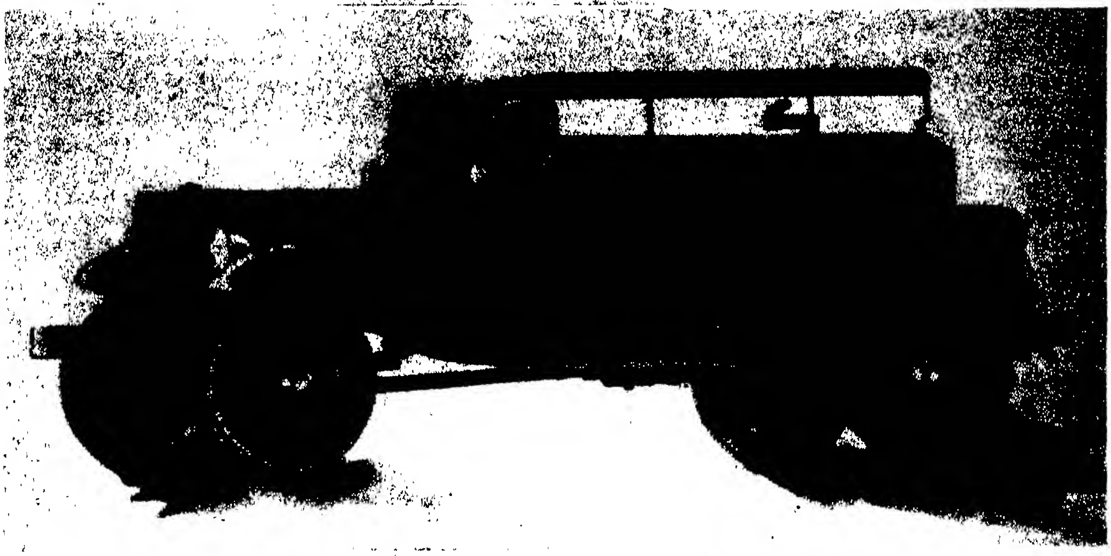
Figure 6: **When the flatness usually required in high grade work, two millionths of an inch, is combined with high angle precision, the problem is compounded**

Military Motorization

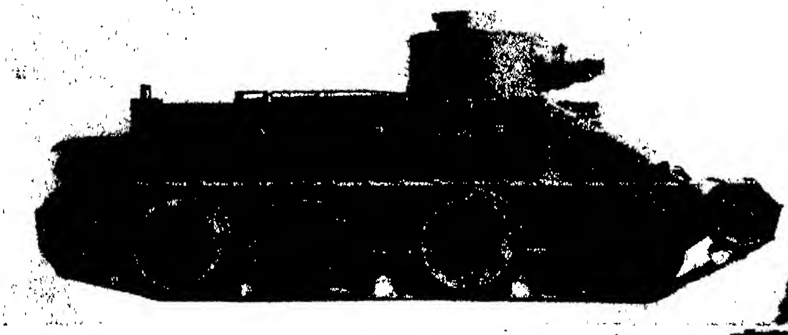


ONE of the many important lessons taught by the World War was the necessity for increased mobility of all sorts of vehicles under fire. Military designers have, therefore, put considerable effort into the problem of building up a motorized army. On this page are shown four of the newer units that have been developed. The armored cars, intended mainly for reconnaissance, will not be subjected ordinarily to machine gun fire and thus have pneumatic tires for greater speed. It is believed, however, that a non-deflatable, soft, sponge-rubber tire may soon be worked out.

A hybrid with great potentialities because of its top speed of 45 miles per hour and its ability to negotiate comparatively rough terrain with ease. Called a "half-track" car, this vehicle was designed in 1933. Its cruising radius is 100 miles



On cars for scouting purposes, even less armor is required than for other types. Adapted from a light commercial truck, this scout car is but slightly armored in its most vulnerable parts. It has a speed of 50 miles per hour



A versatile fighting unit is the Christie tank, shown above. This medium tank, designed in 1930, speeds 30 miles an hour on tracks; with tracks removed, it makes a speed of 60 miles an hour on its solid-rubber-tired wheels. Cruising radius, 100 miles

Photographs courtesy *Army Ordnance*

This armored car, designed in 1932, is a formidable unit. Carrying a crew of four men, it has a cruising radius of 250 miles and a maximum speed of 60 miles an hour. Our criticism is that its tires seem too much exposed and vulnerable to rifle fire

What is Scientific Proof?

The Commonest Mistake... What the Real Method of the Scientist Demands . . . Hard-boiled, Cold, Rigorous Logic . . . Two and Two are Not Nine

By T. SWANN HARDING

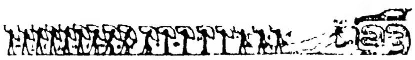
HAVING been trained in science I have what I find to be a particularly bad habit of saying, "But that is not true scientifically." Scarcely anything is more annoying to a person's habitual associates, especially to his wife, than that habit. I am therefore asked in return, and sometimes with scant courtesy: "Then what is scientifically true? How do you prove anything by science? What sort of evidence would convince a scientist?"

Now there are scientists and scientists. Some of them are quite as credulous as other people, particularly about matters removed from their special field, and very often even about matters well within that field. We all err in the matter of belief upon insubstantial evidence. Nevertheless there is such a thing as scientific evidence, and scientific proof is not based upon casual and fortuitous association of events. Let us take a commonplace example.

One of the oracles who runs a very popular newspaper column today remarks that, while Houdini scoffed at superstition, and deliberately made himself 13 at dinner in the June before he died, he did pass on the following December. Moreover, at least one other June diner also died later. Hence one infers that Houdini died because he made 13 at dinner, just as one is expected to infer that every scientist who was at King Tut's tomb dies as a result of an ancient Egyptian curse, whenever and wherever he ultimately dies.

This is not scientific evidence. It is a perfect example of the most respectable and almost the most unavoidable fallacy there is, the one called *post hoc ergo propter hoc*, which means, translated into the vulgate, that because this event has taken place after that event, it was caused by that event. Yet while there is one chance that the preceding event did cause that which followed, there are literally millions of chances that it did not. Other relevant factors were not controlled, as they should be, and there is the rub.

A few years ago an elderly American physician gave an example of the same sort of thing when he wrote: "In 1888, at an international medical congress, I ventured to offer a paper in which I suggested that summer diarrheas of infancy might be due to poisonous milk. When the paper was opened for discussion a learned, elderly man arose, and after making some feeble complimentary remarks directed to the writer, proceeded to demolish all his claims, and finally to suggest that the higher infantile mortality, which was becoming greater and greater every year, could be attributed to the more common use of the baby perambulator because, he said, that the death rate among children in this country has increased since the baby cab had come into use. When I arose to open the discussion, I said that I would withdraw all I had claimed concerning poisonous milk, that the argument adduced could not be contradicted, but I would suggest that the high infantile mortality was due to the fact that we were more in the habit of carrying umbrellas than our ancestors, or that possibly it might be due to the fact that we eat more tomatoes than our grandfathers did."



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A good old-fashioned cold cure, in use as far back as 1175 B.C. In the ancient Egyptian scene, magicians and apes are making magic by tying knots in ropes, muttering spells, and shaking these spells into their hand nets, whence they were cast over the monsters at the right, to rob them of their baleful power and the cold they were causing. "Depart, son of a cold," was the incantation, "every god curses thee." This was as efficacious as saying, "Seven, come eleven!" Probably our best modern treatment for a cold is 24 soft linen handkerchiefs. No progress since 1175 B.C.

This amusing paragraph needs little or no comment. In the same way it may be that increasing appendicitis is to be attributed to the fact that far fewer men carry canes today than some years ago; and so on. What science tries to do, not always successfully, is to survey all the factors in a given situation, to hold all of them constant except the one to be tested, to vary that one, discover what happens, and then connect cause and effect if possible.

Not long ago a gurgling flapper told me that she avoided colds by gargling a popular liquid antiseptic, but that if she did get a cold—of course because she failed to gargle—she ended it more quickly by putting certain drops up her nose. She said the gargle had been proved effective scientifically, because 500 people had been divided into groups, and that some gargled with one preparation and some with another, but those who gargled with this liquid antiseptic had fewest colds. I said that was not a scientific test at all and she became abusive.

IN the first place, there were no "controls," no group of people who did not gargle at all. In the second place, gargling with a weak antiseptic solution could only momentarily reduce the number of germs in the mouth; it would almost certainly leave intact a few of the more virulent varieties which could breed a simply countless progeny in a few minutes. In the third place, careful tests have shown that all common cold remedies give "definite improvement" in from 35 to 42 percent of cases—which is precisely the percentage recovery obtained by the use of milk sugar tablets or by no treatment at all.

Unless recent work at the University of Minnesota (which, by the way, took us back to Dover's Powders and indicated that certain opium derivatives were effective in palliating colds) proves out in the long run, science today knows no definite way either to prevent

or to cure colds. Specialists who have made colds their life study, and who have recently issued a tome of nearly 1000 very large pages, agree that the cause of colds is unknown and that, generally speaking, whereas an untreated cold runs two weeks a treated cold usually runs a fortnight. It is definitely known that no form of gargle can prevent colds, as well as that putting various chemicals up the nose after a cold has developed usually prolongs the cold, and certainly gets the nasal tissues into such a condition that the development of really serious infective complications is enormously facilitated.

But surely vitamin A wards off colds? You can buy that concentrated in cough drops now! Someone actually told me that—forgetting that the cough appeared after the cold had developed, and that this was entirely too late to use a preventive agent with the slightest hope of success. Moreover it has merely been shown on experimental animals that their full complement of vitamin A helps them avoid certain abnormal conditions in certain tissues, those of the respiratory tract among them. There is no evidence to show that a full supply of vitamin A enables human beings to avoid colds.

Indeed, if the gargling flapper had persisted in her argument that she thus avoided colds, because she didn't have colds when she gargled, I might first have inquired into her exercise and eating habits, into the amount of clothing she wore, if any, and her attitude towards ventilation and a thousand and one other factors which were likewise disregarded in the cases of the 500 people who were divided into several groups to gargle with different preparations. Finally I could have remarked that, though vitamin A is reputed to protect against colds, my wife recently caught a perfect hummer of a cold right while she was imbibing a vitamin A and vitamin D concentrate!

IF proof is lacking here, let us consider another story. A few months ago a child died in a midwestern state after having eaten five apples daily for an unspecified period. Her father was a physician and her mother a nurse. The death certificate flatly stated that this tragic end was caused by eating apples which bore arsenic spray residues left upon them by a careless grower. The child was diagnosed as a case of arsenic poisoning, by good physicians who not only examined her excretions and considered her symptoms carefully, but who found that her hair contained an abnormal quantity of arsenic, while that of her brother, who did not eat the apples, was normal in this tell-tale respect. If ever there was a clear-cut case of positive scientific proof this appears to be it, yet there is an obvious and tell-tale flaw in it that gives the whole thing away.

Can we truly say that, because of these things, therefore the child died of arsenic poisoning? We can not. Why? Because the accused apples were never apprehended. They were never analysed and shown to contain dangerous quantities of arsenic. Indeed the apples that were shipped into the state concerned at the time the girl was eating hers were, according to the record, well within the tolerance for arsenic spray residue. Moreover, some persons are very susceptible to arsenic and may be poisoned fatally by minute quantities of this substance, derived from two or more sources, that would have no apparent effect upon normal individuals.

A heifer afflicted with trembles, caused by eating certain plants

Other questions might be asked. What about the possible effects of this sudden and abruptly started habit of eating five apples a day? Isn't that rather a considerable change in diet for a young girl? Might not that factor alone affect her health? Again, might not a few of the apples eaten have by accident contained really excessive quantities of arsenic or, what is more likely and far more dangerous, lead spray residue, which sickened the child? For not many apples could have been so affected, since dozens of other children ate them and went unharmed. Finally, the child may have made up her total minute toxic dose of this drug by accumulating other small quantities of it in other foods.

It is very easy to put 2 and 2 together and make 9 in such instances. Two hasty and ill-informed writers recently put 2 and 2 together and called it 100,000,000 and began, in their hysterical dreams, to imagine that we all were guinea pigs. But, aside from all other considerations, it is the devil's own job to prove that persons are afflicted with arsenic or with lead poisoning. It takes weeks or even months of the most careful laboratory investigation to do this.

Consider lead poisoning, for example. Certain patients enter a certain clinic, assumed to have lead poisoning. Very soon the laboratory workers burst out into a song of joy because they have found "excessive" quantities of lead in the urine of all these assumed victims of lead poisoning. The case was "proved," indeed, until some skeptic asked: "What is an 'excessive' quantity of lead in the urine?" Nobody had thought of that, so they went to work again, still thinking they had found an infallible means of easily diagnosing lead poisoning.

But they next discovered just as much lead in the urine of other sick people in the clinic as in that of those supposed to have lead poisoning. Then they found lead in similar quantities in the urine of several "normal" people who had merely accompanied their sick friends to the clinic. Last of all they found no greater quantities of lead in the urine of certain cancer patients who had been treated with nearly toxic doses of lead, than in the urine of "normal" people. So the theory simply blew up, and a new way of proving that certain people have lead poisoning must be devised.

TO illustrate what scientific proof really means, suppose we take two cases in which the scientists were more successful. Lincoln's mother died of a dread ailment called "milk sickness." That offers us an excellent example. What caused milk sickness? Until scientists in the United States Bureau of Animal Industry recently found out, we did not surely know. The disease was long a violent scourge, with a 25 percent mortality, and it has been known in this country since colonial times.

It was described by physicians as early as 1806 to 1810. One of them wrote: "The yellow fever and the sick stomach (another name for milk sickness) I take to be the same disease, their difference being chiefly in external circumstances. They are both, properly speaking, the bilious fever." This was a blind essay in classification which, however, offered little real enlightenment. But very gradually it came to be seen that sick stomach or milk sickness (also puking fever to some) was most prevalent in late summer or early fall. At this same time the disease called "trembles" was prevalent among cattle. Hence it looked as if the cows consumed some poison at this time and passed it along to the humans who drank their milk.

What could that deleterious substance be? Some said it was poisonous dew or volatile mineral substance that evaporated from the earth at night, condensed on the herbage, and awaited the cattle. Others attributed it to "miasmata," the illegitimate grandfather of germs and the germ theory of disease. Others declared some sort of micro-organisms to be guilty, while others still attributed "trembles" to poisonous combinations of silver, copper, lead, or cobalt found in certain springs. There were those, however, who persisted in believing that the disease appeared when cows ate certain herbs.

Next it became necessary to say what

these herbs were. The following came under suspicion: Virginia creeper, Indian hachy, Indian tobacco, Indian hemp, crossvine, Indian currant, marsh marigold, spurge, fool's parsley, mushroom, and wild snakeroot. As early as 1840, decoctions of wild snakeroot were made by two physicians who convinced themselves that this plant caused "trembles" in cattle, and who treated it with sodium bicarbonate, the recognized remedy today. But many still held then that fungi, or mold on plants, made the cattle ill.

The disease caused in humans, the milk sickness, was a frightful pestilence: it literally devastated parts of the country. The odor of acetone was strong on the breath of victims, indicating faulty metabolism with what is called "ketosis." About 1909 it was demonstrated that there actually was acetone in the urine of these patients. Finally, organic chemists went to work on some of the plants that had so long been supposed to cause trembles in cattle whose milk gave human beings milk sickness. In wild snakeroot or milbane, in rayless goldenrod, and in a close relative of the latter called *Aplopappus fruticosus*, Couch, of the Bureau of Animal Industry, in 1928-1929, found a viscous oil with a pleasant, aromatic odor, of the composition $C_{16}H_{22}O_3$, which classifies chemically with the higher alcohols, and is insoluble in water, acids, and alkalis, but is soluble in most organic solvents.

THIS compound Couch called "tremetol" because, when he administered it to sheep, he could produce "trembles" in them experimentally. It was also shown that the milk of animals which consumed tremetol, either direct or in one of the poison plants, could cause milk sickness in human beings. The meat of such animals remained unaffected and was fit for food. The tremetol passed into the milk. If grazing animals are kept away from the three plants mentioned they never become afflicted with trembles; consequently their milk can not cause milk sickness in human beings and the whole problem is solved scientifically.

It is solved because one factor was isolated. This one factor could then be varied while all other factors were held constant. This was no matter of having 10 groups of 50 people each use different gargles while they dressed, exercised, worked, ate, played, breathed as they pleased, and then trying to conclude that, when all these many factors varied, the one factor, the gargle, prevented or cured their colds. Instead, a definite organic chemical was prepared from plants causing trembles. It was purified. When fed it would cause trembles to a greater or lesser extent depending on the quantities fed.

When human beings drank the milk of cows that had developed trembles from consuming tremetol they got milk sickness. That was the one important factor. But the one factor of supreme importance is not always so easy to find. I will give one more instance to demonstrate this. It concerns a disease of pecan trees called rosette. This disease makes a pecan tree simply curl up and die, and is no end disastrous to the profits of its owner. So scientists from the Bureaus of Plant Industry, and of Chemistry and Soils, began experimenting with various available dips and sprays to prevent or cure the disease, if possible.

A pecan tree "curling up and dying" from rosette. It took a lot of sherlocking to find the cause of it

Finally they found that by dipping the rosetted pecan leaves in a solution of iron sulfate they were able to prevent rosette on young leaves and to improve the condition of older diseased leaves. They therefore sprayed pecan trees the next season with iron sulfate solution, practically certain that this one factor would prevent the development of the disease. But their case was not proved. Rosette appeared just the same. So they checked back on what they had done the previous year.

The analysis of the iron sulfate solution then used disclosed the presence of a considerable quantity of zinc. Where did that come from? Why wasn't there zinc in the iron sulfate solution they were using now? Because last year the solution had been mixed up in galvanized buckets; this year it had been mixed in glass. So-called galvanized water buckets contain zinc. Possibly some of the galvanic coating of the water buckets dissolved in the iron sulfate solution, and perhaps that zinc was the factor preventing rosette. Result? Zinc sulfate was tried; it proved a preventive and a remedy; it was cheap and practical. *Voila!*

We begin to see how difficult it is to connect cause and effect. People who have an itching place on their skin, or pimples, or an eruption, and who try an advertised salve, may in time effect a cure. The laws of chance would account for that. But the cure also may have come about because they threw away leather garters, or changed their dietary habits, or banished begonias from their living rooms, or for any of a number of other reasons. So long as they do not know the cause of the condition it is ridiculous for them to assert that a variation in any one factor of their varied existence effected an absolute cure.

In 1891 a scientist was studying pear blight, and blight is a modest term for what that does to a pear tree. He produced the disease experimentally by brushing its germs into a number of pear blossoms. These germs multiplied in the nectar and entered the nectaries. But how on earth could the disease, thus entering the blossoms, suddenly affect the whole bloom of a tree? That was a mystery till the scientist watched a bee alight on a pear blossom and suck up the nectar. It then flew to another flower, wiped its feet there, and got some more nectar. Therefore it must be the agent carrying this injurious blight from one tree and from one blossom to another.

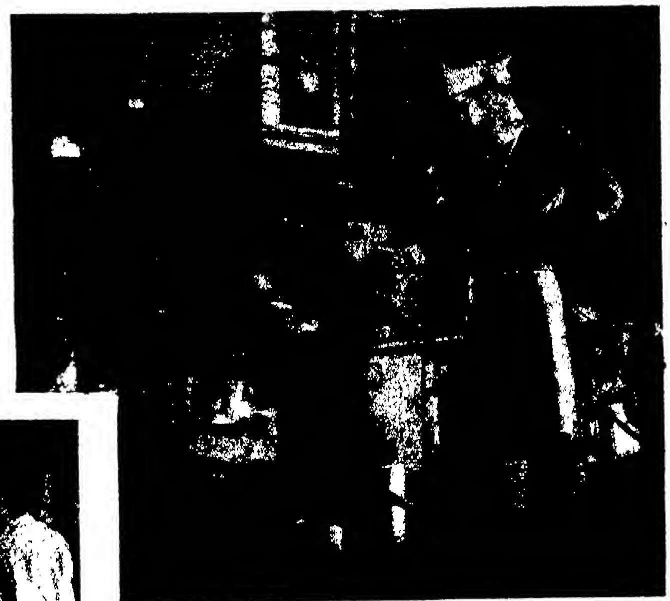
SO the scientist got some sterilized test tubes. He caught three bees in the act of sipping infected nectar. He examined them under a microscope and found the disease germs in their mouths. From these germs he developed cultures. The organisms which grew on his cultures were typical pear blight germs because they produced pear blight when inoculated into pear trees. The disease so produced was proved to develope again the same kind of germs, which could again be taken from the nectar of the pear blossoms by the honey bee. The case was proved scientifically and it is that sort of thing I have in mind when I demand scientific proof.

It is a good method to test out the stories we hear about cures and other things for *post hoc ergo propter hoc.* We should ask: Did this cause that? How many factors were varied? How much care was exercised in proving that the factor cited actually did produce the result attributed to it? Do rheumatics who take fake remedies that consist, in the ignorance of the victims, of salts, actually cure themselves of rheumatism, or do they merely feel better because they needed a dose of salts anyway . . . or because the weather changed . . . or their diet changed . . . or because they ceased driving in an open car, or sleeping next an open window . . . and so on and so on?

Scientific proof is most difficult to establish. But it is well worth the effort just the same.

From Metal to Money

Scenes in a U. S. Mint



Precious alloys for coinage are melted in these gas-fired furnaces for casting into uniform ingots. Each furnace is built of refractory material and covered with sheet steel. A gas burner fires into the furnace, so that flames envelop the crucible containing the metal

Molten gold or silver is transferred from the furnace crucible to this pouring table where it is cast

A LARGE part of the wealth of the nation, in the form of gold and silver, is housed in the U. S. Mint at Philadelphia, where these unusual photographs were taken. Gold U. S. coins are 90% gold and 10% copper; silver, the same ratio of silver and copper.

When the ingots leave the casting table in the form of bars 2⅛ inches wide, ½ inch thick, and a foot long, they go to the rolling mills where they are reduced in thickness to the required dimension for the coins to be stamped

After the ingots of precious metal are rolled to the required thickness, the strips are put through blanking presses where blanks are cut to the exact sizes for various coins. These blanks are then annealed, cleaned in an acid bath, and coined in a stamping press such as the one shown above. The blanks are pressed between engraved steel dies, surrounded by a collar which mills the edges at the same time

The Philadelphia Mint is equipped with long lines of the various machines required for coining—rolling mills, blanking presses, coining presses, and so on, all power driven. After the finished coins are inspected by trained observers, they are individually weighed in the device shown at the left. Coins are pushed from the tubes, one at a time, automatically weighed, and dropped into a container

Eyes of the Fleet

By ANDREW R. BOONE

When the *Ranger* joined the Battle Force at San Diego, California, recently, the effective power of fighting airplanes with the Fleet was increased nearly half. The first aircraft carrier designed and built by the United States Navy expressly for that purpose, the *Ranger* carries 79 planes, bringing the Fleet's carrier-based armada to a total of 271 fighters, scouts, bombers and torpedo planes.

Although only about half as large as the *Saratoga* and *Lexington*, whose keels were laid down as battle cruisers, the *Ranger* carries as many planes as either. She attains a high speed of more than 30 knots, faster than any battleship, and can, through sheer speed, escape from an enemy fleet in broad daylight. She is twice as large as the *Langley*, first of Uncle Sam's carriers.

Like the larger carriers *Saratoga* and *Lexington*, the *Ranger* has a clipper bow and an "island" on its flying deck for navigating stations. With a displacement of only 13,800 tons, the *Ranger* is 769 feet long, as compared with 888 feet and 33,000 tons for the two larger carriers. The *Langley*, converted from the collier *Jupiter*, is 542 feet long and is now 23 years old.

How planes are "arrested" when landing on the *Ranger's* deck is a closely guarded secret, but tests have demonstrated that her brood can land on the long flight deck and be stowed away below by means of quick-action elevators faster than on any other carriers. The flight deck, longer than two city blocks, is 85 feet wide.

These four carriers will accompany the fleet during all war games until the *Yorktown* and *Enterprise*, each slightly larger than the *Ranger*, are completed in 1937. Then the *Langley* will be retired.

[*Important Announcement*—*page 170*. Ed.]

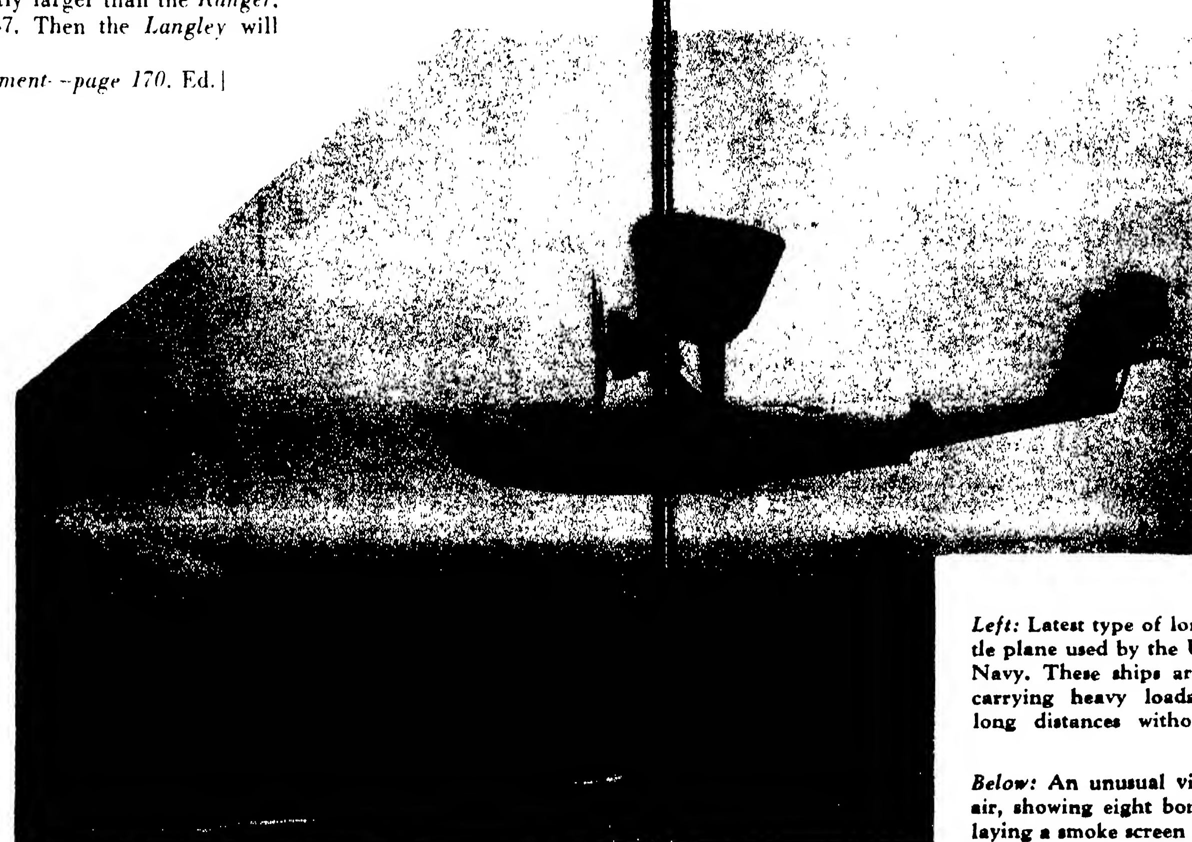
A view of the *Ranger*, n[...] and speediest of our aircraft carriers, showing the "island" and the three stacks that may be folde[...]board the *Ranger* are based 79 fighting, observation, and bombing planes

Three fast Navy fighters of the same type as is shown in the circle bel[...]

Left: Admiral J. M. Reeves, Commander-in-Chief of the United States Fleet, has at his disposal one of the world's most powerful naval air forces now in existence

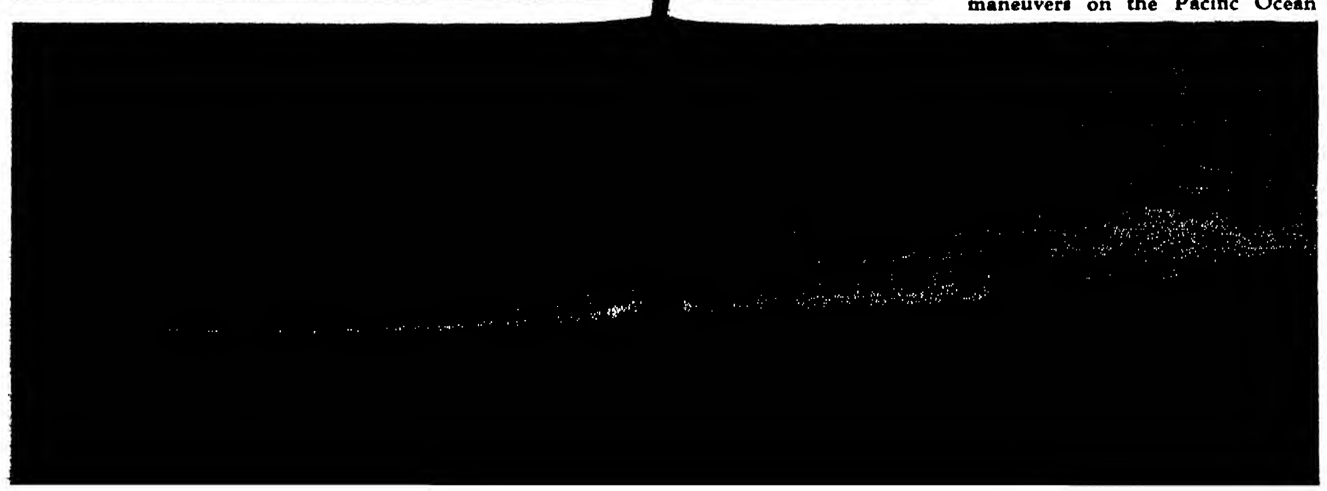
Below: Ships that pass over the fog. A giant Navy patrol flying-boat roars past a squadron of bombers high above the Pacific

Right: One of the latest Navy fighters, based on the *Ranger*. Note the landing wheel retracted within the fuselage of the plane

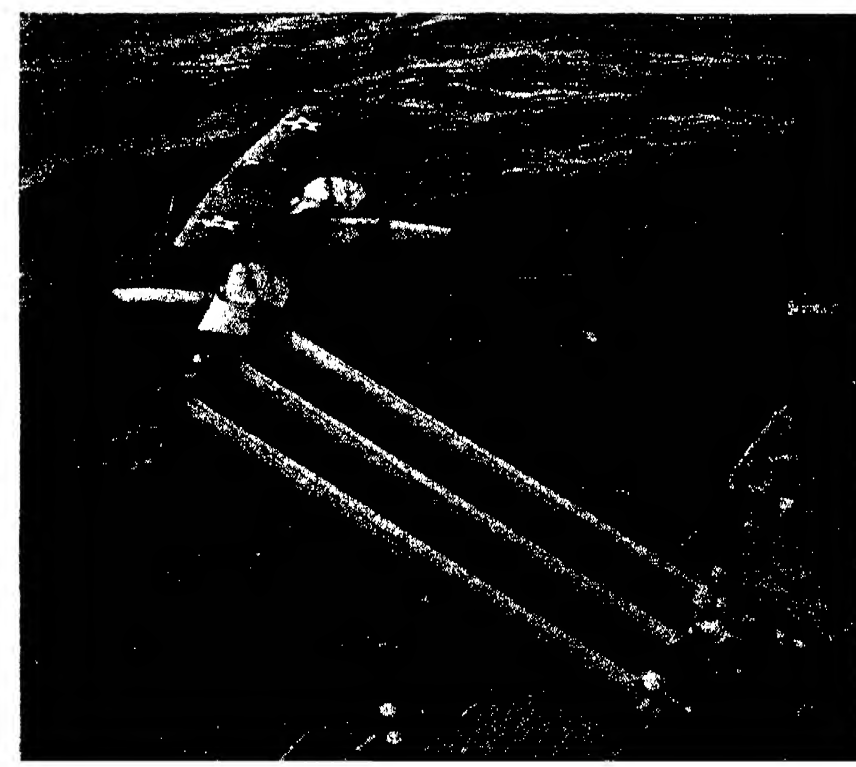


Left: Latest type of long-range battle plane used by the United States Navy. These ships are capable of carrying heavy loads and flying long distances without refueling

Below: An unusual view from the air, showing eight bombing planes laying a smoke screen during battle maneuvers on the Pacific Ocean



Lower right: A spotting plane, equipped with pontoons for landing on water, being discharged from a catapult on board ship



MAKE YOUR OWN

LIGHT-SENSITIVE CELLS

Supply Five To Ten Milliamperes . . . Operate Relays . . . Easy To Make . . . Low In Cost

By JOHN H. RADU
Instructor in Metal Science and Glasswork
Stuyvesant High School, New York

VARIOUS kinds of light-sensitive cells are on the market, but the cuprous oxide cell to be described here can be produced in any size desired, and without complicated equipment. It is very reliable and sensitive, and with it many interesting experiments can be performed in the home or shop. This cell will produce sufficient current to actuate a relay without additional batteries, when a beam of light is thrown upon it or when a beam of light is intercepted.

Everyone who is familiar with the relay knows that there is no end to achievement with it when positively actuated. For example, it will sound burglar and kidnap alarms, open and close doors, and turn lights on and off. Yet the writer has seen no published instructions that include all the essentials required to produce a reliable cell for actuating such relays. After many experiments he has devised the following simple and inexpensive method which may be pursued in producing such a light-sensitive cell.

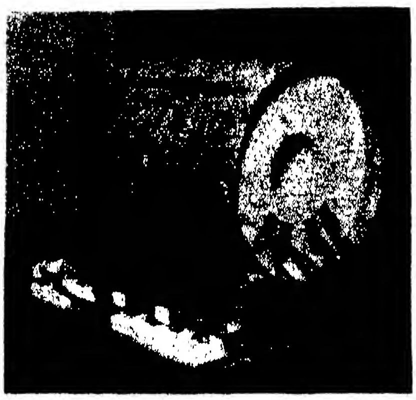


Figure 1: **The author's furnace used to make cuprous oxide plates**

Before we can construct the actual cell we must first have a good furnace. While a gas furnace may be used. if hot enough, a small electric resistance furnace, large enough to allow the plate of the cell to be suspended within it while being treated—one that will heat the copper to almost 1000 degrees, Centigrade (about 1800 degrees, Fahrenheit), or close to the melting point of copper—will serve better than any other kind. So let us first describe the construction of such a furnace, and then of the actual cell.

If constructed by your own hand an electric furnace will require only a small outlay of money. Furthermore, it may be put to many uses besides making the cuprous oxide element—for example, baking enamel. By an arrangement of switches (without using a rheostat in the circuit) you will be able to obtain various degrees of heat. For the cuprous oxide element, however, you will switch the coils in parallel, and when connected in this way the current consumption will be about nine amperes at 110 volts, giving a temperature of approximately 1000 degrees, Centigrade.

THE cuprous oxide photo-voltaic cells described in this article will provide the basis for considerable experimental work in the field of photo-electricity. They also make available to the experimenter a reliable unit for use in connection with many devices to be operated by a beam of light. Information on relays to be used with these cells will be supplied upon request. Please send a stamped addressed envelope.—*The Editor.*

IN preparing the several parts of the furnace, accuracy of measurement is important. Therefore it is recommended that the builder adhere to the directions exactly as they are presented.

Secure the following, which should total less than ten dollars[1] in cost.

(1) A 20-gage galvanized sheet iron cylinder, 10½ inches long and 9 inches in diameter, for the shell of the furnace. Rivet the seam or bead it. (Figure 1.)

(2) Two pairs of hoops made of iron or mild steel, 1 inch wide and about 1/16 inch thick, of such diameter that each pair, one on top of the other and their joints opposite, may be placed in either end of the cylinder. This is shown in Figure 1.

(3) Four disks of ¼ inch asbestos board to fit the inside of the cylinder. (Figure 2.) In each of two of the disks cut a hole having a diameter the same as the inside of the quartz tube (item 4, below). Cut holes in the remaining two disks, large enough so that they will fit comfortably on the outside of the tube.

(4) A Vitreosol molded pipe, 8 inches long, with a 3-inch bore.

(5) Two coils of No. 20 B & S gage "Nichrome IV" wire.

(6) Five pounds of Alundum cement RA-162.

(7) Four terminals (Figure 1, beneath central hole).

(8) Some sheet mica--purchasable locally.

First, make a double twist 3 inches long, at each end of two pieces of the Nichrome wire 43 feet in length, leaving two resistors each 42 feet long. Firmly anchor one end, with the twist about an inch from the end of the tube, and begin to wind, spacing the turns ⅛ inch apart.

Apply pieces of sheet mica (ordinary mica, but not Micanite, will be suitable) ranging from .005 to .010 inch in thickness, under the wire as you proceed. It is most important that the mica separate the wires from the quartz tube,

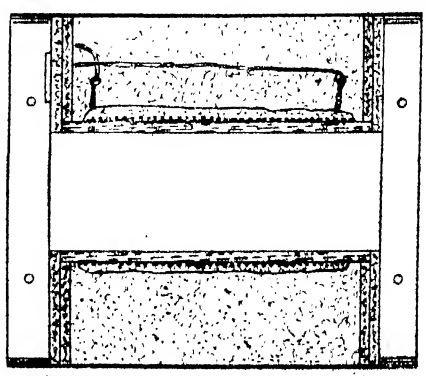


Figure 2: **A cross-section drawing of the furnace illustrated at left**

[1]A list of supplies and dealers may be obtained from the Editor.

in order to avoid any reaction. When you reach the other end, anchor it also, and wind the second wire between the coils of the first one. It is usually good practice to wind a cord along with the wire, to keep one wire separate from the other; on completion remove the cord.

With Alundum cement and water, prepare a *thin* paste, and cover the wire well with it. When it is partially set,

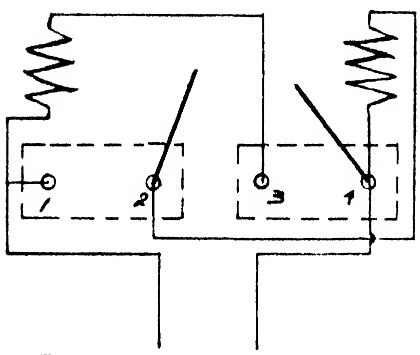


Figure 3: **Two switches make it possible to change coil connections**

make a *heavy* paste of the same material and completely cover the wires until you form a wall approximately ¼ inch thick. Allow this coat to dry slowly, thus preventing it from cracking.

Attach securely to each of the four ends you have twisted (on the original lengths) a piece of No. 14 B & S gage copper wire that is long enough to reach the terminals on the outside of the asbestos disk.

Cut in either asbestos board disk some small holes to permit bringing out the wires, and attach the four terminals to the outside of one of the disks with machine screws.

SECURE a pair of hoops to the inside of the shell at one end, with six No. 10-24 or similar screws and nuts, the holes for these to be equally spaced. Set the tube on end and insert the disk with the terminals, and then the disk with the holes for the wires, keeping the holes in a direct line with the terminals. Put in place the quartz tube with its coils, and fish the wires through the holes of the asbestos disk you have already placed. Fill the space between the coils and the outside cylinder as compactly as is possible with infusorial earth or magnesium oxide, within ¼ inch of the end of the quartz tube. Slip one disk with a large hole over the end of the tube, and then the fourth disk on over that one. Put in place the second pair of hoops and fasten them as you did the first pair, thus completing the heating element of the furnace.

It is sometimes convenient to use the furnace in a horizontal position, and at other times in a vertical position. If you mount the furnace on feet, fastened to a board, in order to steady it (Figure 1), you will find your work considerably reduced during experiments with it when it is kept in a horizontal position. But note also the lug in the upper right hand part of the furnace. This serves as a leg when you wish to use it in a vertical position. In either horizontal or vertical position the furnace requires a plug at one end. This may be made of fire clay, obtainable locally. The vertical position, which is best for suspending cuprous oxide plates, calls for a plate of fire clay or a piece of mica on the top of the furnace, but when you use it horizontally two plugs will be necessary.

Figure 3 shows the wiring and switching arrangement, using two single-pole, single-throw switches (Figure 1, at nearer end), so placed that you can throw the knife of one switch into the jaws of the other. When you connect points 1 and 2, one coil will be in circuit; when you connect points 3 and 4 the other coil will be in circuit. When you throw in both switches you connect the coils in multiple, and when you connect points 2 and 3 the coils will be in

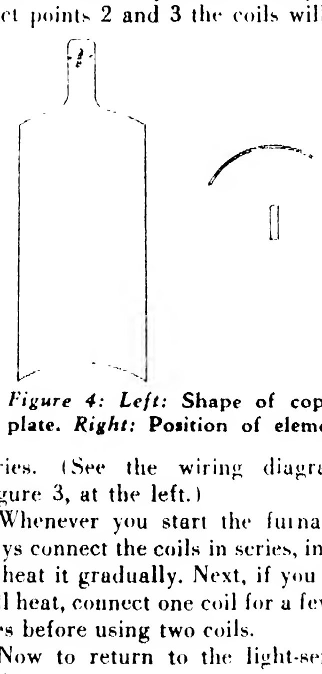


Figure 4: Left: **Shape of copper plate.** ***Right:*** **Position of elements**

series. (See the wiring diagram in Figure 3, at the left.)

Whenever you start the furnace, always connect the coils in series, in order to heat it gradually. Next, if you desire full heat, connect one coil for a few minutes before using two coils.

Now to return to the light-sensitive cell:

Procure a sheet of 18-gage copper (.040 inch thick). Electrolytic copper will prove to be the most satisfactory kind. A desirable sized plate to begin with is about 2 inches wide and 3 inches long, and curved to fit a glass container of suitable size. After shaping each plate (Figure 4) on which you will include a lug at one end, remove all sharp edges and corners with a file.

Hammer the lug into cylindrical form. If you make use of copper having the same thickness, and the same lug dimensions as recommended in Figure 4, you may thread the lug with an 8-32 die, thereby making provision for mounting and connecting with 8-32 nuts.

When the copper plate is ready, clean it in a hot solution of 5 to 10 percent sulfuric acid, then wash it in clean water. Suspend it in the furnace until it nearly reaches its melting point. Keep it at this temperature for about five minutes. You will observe the surface becoming glossy, an indication of the formation of cuprous oxide.

Cool the plate slowly. If you use the electric furnace, merely cut off the current, but if a gas furnace is used, shut it off completely. Let the copper remain inside until cool. This slow cooling process will prevent the cracking and peeling of the material formed on the surface. While cooling, a black film of cupric oxide forms a cover over the dark red cuprous oxide. You may easily remove this by dipping the plate into a weak solution of potassium cyanide (a poison). Take great care not to leave the plate in this solution too long. Should any exposed copper appear, paint out those spots with hot beeswax or paraffin, in order to prevent the electrolyte from attacking the copper and ruining the cell.

YOU have now completed the most important part of the light-sensitive cell. Next make a second element, which consists of a thin strip of lead (Figures 4 and 5) secured to a lug or screw for mounting purposes.

Next, the assembly: A glass cylinder (a flat-bottomed jar about 3¾ inches high and 1½ inches in diameter will answer; those in Figure 5 are common pickle jars) should be selected before you shape the plate. Fit the cork or other stopper tightly into the top of it. If a cork is used, dipping it into a hot solution of beeswax or paraffin will add to its efficiency. On this, mount the cuprous oxide element and also the strip

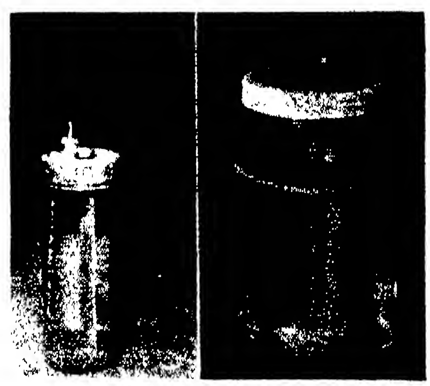


Figure 5: **Two completed cuprous oxide cells made by the author**

of lead; approximate the positions shown. Pour lead nitrate solution (strength 1 to 1½ percent) into the cell until the liquid rises to a point within half an inch of the cork, after the assembling.

A cell, if accurately made in accordance with the above description, and if the plate is properly coated with cuprous oxide, will supply from five to ten, and sometimes more, milliamperes, according to the strength of the beam of light cast upon it.

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

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Measuring the Sunshine in Milk

PARENTS and physicians alike rejoiced when it became possible to put vitamin D into milk. Milk is in many ways an ideal food for infants and children but it is sadly deficient in the sunshine vitamin, as vitamin D is often termed.

Now scientists have gone a step further and found a way to measure the amount of sunshine vitamin in the milk when it is put there by the action of ultra-violet light. This is important. Baby specialists and nutrition experts have recently pointed out that lack of such a measure was one serious drawback to relying on vitamin D-enriched milk as the sole source of this vitamin.

Measuring the amount of ultra-violet light playing on milk during the irradiation process. Man at top of the vat is holding a photo cell sensitive to ultra-violet rays

The method of measuring the sunshine in milk was developed by Dr. H. C. Rentschler of the Westinghouse research laboratories and tested by Dr. G. C. Supplee in the plant of the Borden Company.

Strictly speaking, Dr. Rentschler's newly-announced method does not measure the actual amount of the vitamin. Instead it measures, by the photo-electric cell, the amount of ultra-violet light playing on the milk during every minute of the irradiation process.

This is all that it is necessary to measure, Dr. Supplee explained, since scientists have known for years the amount of irradiation needed to impregnate the milk with the required amount of vitamin D. The big thing was to find a way of making sure that this required amount of ultra-violet light was reaching the milk constantly during the process, so that every quart of the irradiated milk delivered to a baby's home would contain the actual amount of vitamin D it was supposed to have.

Other ways of putting vitamin D into milk have been found besides the irradiation method, but Dr. Rentschler's new measure is only useful for determining the vitamin-D content of irradiated milk.—*Science Service.*

WATER WEIGHT

NEVER before has man placed such an enormous weight on one spot of the earth's crust as he has in impounding the water behind Boulder Dam. It is estimated that the weight of the lake alone is 41½ billion tons. It is almost certain that this additional weight will cause adjustments in the earth's crust in the locality of the dam.

Fingerprints "Raised" from Cloth

A NEW weapon is being placed in the hands of crime fighters in the form of a fingerprint detection system being developed by the Technical Research Laboratory of the New York Police Department in collaboration with Honorary Police Surgeon, Dr. E. M. Hudson. The new method makes it possible to disclose fingerprints on materials such as cloth, paper, wood, and so on, which will not yield prints by the ordinary powder method. The silver nitrate method is based upon the reaction which takes place between a chemical and the body salts which are always deposited when a fingerprint is left anywhere. One of the most fertile fields which this method opens is the development of latent fingerprints on clothing.

Essentially the procedure is as follows: The material on which it is suspected that a fingerprint has been placed is treated with a 10 percent solution of distilled water and silver nitrate to which has been added a small percentage of acetic acid, or the material is immersed in about a 10 percent solution of acetic acid after immersion in the silver nitrate solution. The solution of silver nitrate is applied by brushing, spraying, or immersing, or the cloth or paper is passed through a clothes wringer having a well from which the solution is applied to the rollers. The material is then placed to dry in a dark room. After drying it is exposed to sunlight or to ultra-violet light. The silver nitrate reacts with the sodium chloride left by the fingers, forming silver chloride which turns dark on exposure to light much faster than does silver nitrate which has not come in contact with the body salts.

After the light has developed the fingerprints to the desired intensity, the material is washed in water to remove as much as possible of the excess silver nitrate. The silver chloride, being insoluble in water, remains. The developed latent finger impressions on the material are now fixed by treating them with about a 5 percent solution of ammonium hydrosulfide or applying a weak hypo fixing solution. When the latter chemical is used, great care must be exercised to prevent the destruction of the

A fingerprint developed on cloth by the chemical process described

silver chloride and consequent ruining of the print. The material is again washed in water to remove all substances therefrom except the silver chloride, and then placed to dry, after which heat is applied by a laundry iron.

The silver nitrate method can be used on cloth, paper, wood, and other similar materials for developing latent fingerprints, and can also be applied to paper for bringing out or developing latent or contact impressions of writing left by a pencil, pen or other similar object.

GAS TAX

NEARLY 40 percent of the motorist's bill for gasoline goes for federal, state, and local gasoline taxes. The average gas tax on June 1, 1935 was 5.28 cents per gallon.

PROGRESS In This Age Of Science

As Told to SCIENTIFIC AMERICAN

By LEWIS H. BROWN

President, Johns-Manville Corporation

PRACTICAL application of science to everyday life is so common to the present generation that we are prone to take it as a matter of course, especially in the fields of transportation and communication. The building industry has also made great strides in development of better building materials and better construction methods.

Science has put at the disposal of the builder and architect materials that are fireproof, more permanent, and more economical to apply in erection of modern homes or commercial buildings. Methods that were hitherto impossible, because of the limitations of available materials, have resulted.

Ways and means of increasing our personal comforts in office and home have also been developed by science. Today it is possible to have a building completely insulated against extremes of outside temperature, winter or summer. Air-conditioning equipment likewise has been perfected to the point of practicability for even a modest structure.

Elimination of harsh, unwanted noise, so disturbing to thought and nerves, by use of sound absorbing materials that transform noisy offices and workshops to places of comparative quiet, with great increase in workers' comfort and efficiency, has been gained by science after years of laboratory research.

Business and governmental agencies of recovery are focused on the building industry, and with the widespread public interest in new homes, it is not too much to expect that new and greater contributions to building will be forthcoming from the research laboratories of industry.

STEAM COMPETITOR OF DIESEL ENGINE AS POWER SOURCE

A STEAM boiler which may bring a new era into the generation of power aboard warships, especially those of the destroyer class (and perhaps submarines) was described in a recent issue of *Mechanical Engineering*. So efficient is the device that it makes steam a competitor of the Diesel engine.

The ultra-modern boiler is highly compact, light in weight, and can be easily adapted to the narrow hulls of destroyers, according to Adolphe Meyer of Brown, Boveri and Company, Baden, Switzerland. The boiler is already coming into use throughout Europe. Because the fuel gases travel faster than sound in some parts of the boiler, it is called "Velox," coined from the word velocity.

The new Velox steam boiler that holds great promise for the future

The weight of the Velox steam generator is only one fifth that of the ordinary oil-fired water tube boiler, while it occupies only one half as much space as even the most modern marine boilers.

"In submarines," says Mr. Meyer, "the small masses, the possibility of rapid cooling by running cold air through the boiler, and the small dimensions of the exhaust pipes enable the time required to prepare for submerging to be reduced to an extent hitherto only to be obtained with Diesel engines.

"In comparison with the Diesel engine," adds Mr. Meyer, "the Velox steam generator has the advantage that every kind of oil can be used and there is no restriction as to the use of the more expensive gas or Diesel oil."

In warships, the Swiss engineer explains, the full steam output is ordinarily obtained by forcing the boilers to about three or four times the amount which such a boiler would normally give if used for other purposes. An efficiency of 75 percent or less is obtained under such forced conditions. By comparison, the Velox boiler has an efficiency of between 88 and 90 percent. An additional naval advantage is that the exhaust gas from the boiler is completely invisible even at maximum output.

Special advantages of the new type boiler are:

1. It can be brought up from a cold condition to its full load steam generating capacity in from four to eight minutes.

2. Changes in load can be handled quickly. A drop of 50 percent in the load can be dealt with by an automatic control device in but 20 seconds. Even when the full load is cut off suddenly, the boiler will not blow off.

As in warships, the best features of the Velox type boiler—small space requirements, light weight, and high efficiency—exactly fit the needs of railroad locomotives

The Velox generator operates essentially as follows:

Air and fuel are mixed in a burner at the top of the combustion chamber and are blown into the chamber to burn. The entering velocity is over 1200 feet a second. Lining the walls of the combustion chamber are hollow evaporator tubes containing many small pipes. These small pipes are part of the water circuit of the steam generator.

Power is obtained from the device in two ways:

1. By the action of the swift-moving exhaust gases on a gas turbine which drives a blower. The blower is used to mix the air and fuel in the intake burner.

2. By the action of superheated steam on a steam turbine which drives an electric generator directly coupled to it.

Following through the mechanism by which the exhaust gases are used directly to obtain power for the blower, the first step is the partial loss of the heat of combustion to the outer walls of the evaporator tubes. Still more heat is lost as the combustion gases go down to the bottom of the combustion chamber and then back up inside the evaporator tubes. This heat is transferred to the water inside the pipes filling the evaporator tubes.

Continuing on their way, the exhaust gases, now down to a temperature of 1500 degrees, Fahrenheit, enter the superheater. By the time the gases have left the superheater, their temperature has fallen to 900 degrees, Fahrenheit, and their velocity is between 330 to 600 feet per second. Traveling at this rate, they strike a gas turbine.

The gas turbine, in turn, drives a blower

which is used to send more air and fuel into the device.

Finally the exhaust gases, now down to a temperature of 700 degrees, Fahrenheit, pass out through the chimney on whose inner walls are pipes containing the water which will eventually become steam in the water-steam system of the machine.

The water-steam system starts therefore in the chimney of the steam generator. The incoming water is warmed here and passes into the evaporator tubes inside the combustion chamber, where the real heating takes place.

The steam and hot water thus formed issue from fine nozzles into a vertical drum. This drum acts as a centrifuge to separate steam and water, the latter falling back for more heating and the steam passing on to the superheater.

The steam at 600 pounds to the square inch pressure and temperatures as high as 850 degrees, Fahrenheit, passes to a steam turbine driving an electric generator directly coupled to it.

Safer Airplanes?

THE most interesting part of the recent Detroit Aircraft Show was the controversy between Eugene L. Vidal, Director of the Air Commerce Bureau, and the manufacturers of airplanes for private flying. Speaking before the Association of Aviation Editors, Mr. Vidal served the following warning on the manufacturers: "We are thinking now in terms of three classes of airplane licenses: One for the safe, easily operated ship, which the Bureau of Air Commerce is striving to develop to popularize private flying; one for the present-day airplanes of the private owner type, and a third for fast-landing, high-speed craft of the modern transport type. The public has a right to know that there is a vast difference between the flying characteristics of such ships, and we mean to label them so it at least won't have to go into aviation blindfolded."

This position would be a very sound one to take, were it demonstrated beyond all doubt that the new planes sponsored by the Department of Commerce are indeed highly developed from a safety point of view. Manufacturers are not at all convinced that this is indeed the case, and give as their opinion that the Department makes premature announcements, which decrease sales.

The controversy between the "New Dealers" in aviation, and the manufacturers who believe in evolution began more than a year ago with the 700-dollar "flivver" airplane. Mr. Vidal announced the early advent of the cheap, popular airplane, to the temporary detriment of private plane sales. The flivver plane never materialized and Mr. Vidal explains this by saying that the Public Works Administration "welched" on a promised appropriation of 900,000 dollars.

AIR BUSINESS

THE civil aeronautics industry in the United States produced aircraft, engines, equipment, and spare parts valued at over 44 million dollars in 1934, and furnished employment for more than 18,000 persons, according to the Bureau of Air Commerce, Department of Commerce.

After the controversy regarding the 700-dollar airplane had subsided, the Air Commerce Bureau organized a competition for a "safe" private airplane. The Hammond Y, built by the Hammond Aircraft Corporation and illustrated in our photographs, was the winner in this competition, and an order for 15 machines was placed. The Hammond Y is powered with a four-cylinder in-line Menasco air-cooled engine, and has full instrument and other equipment, with provision for 40 pounds of baggage and a parachute for each passenger. The fuselage is of all-metal construction and the door is near to the ground to facilitate entrance.

The Hammond is a pusher with the engine to the rear of the cabin, and a scoop delivering air to the engine compartment. The tail surfaces are carried at the end of two booms extending backward from the wings. The landing gear is of the three-wheel type with one castorable and steerable wheel placed ahead of the fuselage or nacelle.

Here are the arguments in favor of the new aircraft:

1. Very large dihedral, and large vertical tail surfaces, providing good lateral stability.
2. Low wing loading and no tendencies to go into a stall-spin condition.
3. With the engine to the rear, exhaust fumes, motor, and propeller noise do not affect the passenger.
4. With the pusher arrangement, there is perfect visibility ahead.
5. With the front wheel landing gear, it is impossible to nose over. No matter how little skill the novice may show in landing the plane, it will immediately settle into its normal position on the ground, and brakes may be violently applied with impunity.
6. Upon take-off, it is only necessary to pull the stick back, and then to open the throttle. The plane will take off without further worry.
7. The rear wheels being fixed and back of the center of gravity, there is no danger of "ground looping" in taxying; that is, of an uncontrollable turn on the ground. This is particularly important in cross-wind landings.

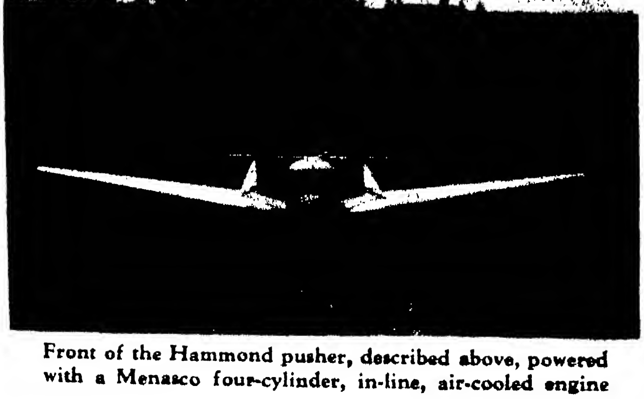
The arguments against the design are:

1. The public does not like pushers, and will not fly with an engine at the back of its neck.
2. Conventional planes do not nose over, spin, or ground loop except under very rare circumstances.
3. For the same weight and horsepower, conventional planes are apt to be very much faster. The stumpy nacelle, the two booms, the struts to the wing from the nacelle, make the Hammond rather slow, and it is an open secret that the Y has not met its maximum speed requirements by more than ten miles an hour, and is in process of refinement or "cleaning up."
4. Light wing loading is a hazard in gusty weather and exaggerates bumps.

Nobody will ever settle the argument. There is no doubt that eventually an improved and speedier Hammond will enjoy favor in many quarters, although previous examples of this type of design (as the Stout Sky Car of 1930) never made a hit with the flying public. At the same time private conventional airplanes capable of 150 miles an hour and more will still attract the majority of buyers, giving them the speed which is the main justification for flying, with a safety considered quite reasonable. The new type three-wheel landing gear is perhaps the one feature of the Hammond which it would be most desirable to see incorporated in the conventional tractor airplane, and in any case the new designs will bring controversy and discussion—which invariably advance the art.—*A. K.*

Airplane versus Bird

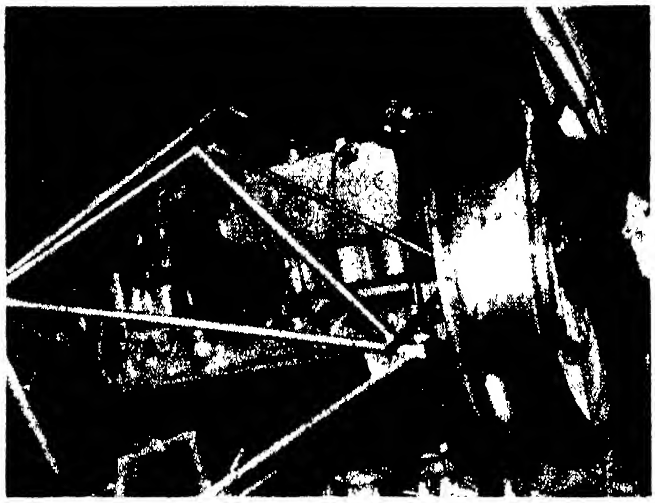
WE have often been asked what would happen to an airplane if it struck a large bird. The Navy Bureau of Aeronautics answers the question authoritatively. A Navy pilot flying in an observation plane to Cape May, through thick mist, was surprised to see a large bird loom directly ahead and in line with his propeller. The pilot and bird maneuvered to get out of each other's way but neither was quick enough. The bird

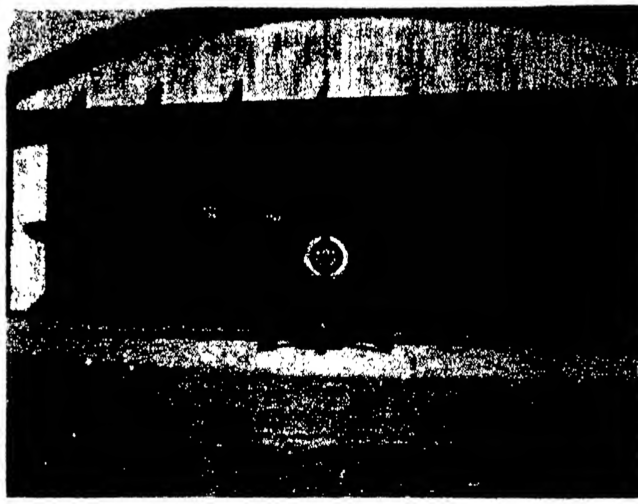


Front of the Hammond pusher, described above, powered with a Menasco four-cylinder, in-line, air-cooled engine

Side of the Hammond plane, showing the three-wheel landing gear, the attitude of ship at rest, and the booms

An ordinary automobile engine, adapted to and installed in an airplane, that has passed its 50 and 100 hour tests





A front view of the high-wing monoplane, equipped with a converted automobile engine, which is described below

struck the leading edge of the right upper wing at the outboard strut and jarred the whole airplane. The pilot flew back to his station with one wing flying several shredded pennants. An inspection of the damage showed eight broken compression ribs, with several feathers measuring about ten inches long still held by the torn fabric and bent metal. It was concluded that the bird had a probable wing spread of 30 inches and was one of the larger species of sea gulls. —*A. K.*

Automobile Engines in Flight

MANY motorists will recognize the engine used as the power plant of an airplane, as shown in one of the accompanying photographs. A few hundred a year constitutes "production" for aircraft engines; automobile engines are built at the rate of hundreds of thousands a month. That is why automobile engines are far cheaper than the aircraft engines of to-day. Accordingly, the Department of Commerce in its "low price for airplanes" campaign has placed a number of orders for the conversion of well known automobile engines to airplane use.

A standard Plymouth engine has recently passed its 50-hour aircraft engine test, as well as its 100-hour manufacturer's tests, without a hitch. A minimum of changes was found necessary for the conversion. The engine was stripped of its flywheel, electrical equipment, and radiator fan. An aircraft magneto, updraft carbureter, and sheet metal exhaust manifolds were installed. An aluminum cylinder head was used to reduce weight and to raise the compression ratio from 6.7 to 7. A 2-to-1 reduction gear was provided to reduce the propeller speed to 1800 revolutions per minute, more suitable for plane operation than the high automobile engine speed which is now standard practice on the road. The weight of the converted engine is 398 pounds, and it develops about 80 horsepower. This gives a weight ratio of about five to one, which is more than twice as high as would be the case for an aircraft engine of equal power. This comparatively high weight ratio is of course a handicap in plane design, where every pound counts. Nevertheless the converted engine has given excellent service in a high wing monoplane, enclosed cabin type, built by the Fahlin Manufacturing Company. With a weight empty of 1075 pounds, and over four hours cruising radius with pilot and passenger, the Fahlin has a top speed of 115 miles per hour and is giving satisfactory flying service in every way.—*A. K.*

The Ultimate in Resistance Reduction

THE resistance of the airplane may be divided, broadly, into three parts as follows:

1. That due to lift (induced drag as the technicians call it). At the tip of a wing there are end flows and energy losses. These losses become smaller as speed increases. At very high speeds, the losses due to lift become negligibly small, and that is precisely the reason why the speed of the airplane has been increasing so rapidly of recent years.

2. Eddy losses due to projections pocketing the air. These have almost disappeared in the modern airplane, with its beautifully streamlined forms, retractible landing gears, and so on.

3. Skin friction losses. These are present no matter how well streamlined the airplane may be. When the airplane is flying very fast and is well streamlined, it is mainly skin friction losses that remain to be conquered.

Next to the very surface of the wing or fuselage, the air is at rest relative to the body. Within a narrow layer, termed the "boundary layer," the velocity rises from zero to the velocity of the machine itself. Near the leading edge of the wing, the flow is "laminar" or smooth, with the sheets of fluid slipping over another without mixing. Some distance from the leading edge, the flow is no longer laminar but "turbulent," with the particles crossing from one layer to another and generally behaving in irregular fashion.

Now turbulent skin friction is *eight times* as great as laminar skin friction. The next important step is therefore to study the flow in the boundary layer, and to devise means for maintaining the laminar flow over the entire surface of the body—by extra smoothness, by the application of suction, perhaps by moving surfaces, or perhaps by learning something from fishes.

This problem of maintaining laminar flow is a real challenge to aerodynamicists, engineers, and inventors. Its solution will have far reaching results.—*A. K.*

'PLANE SHOES

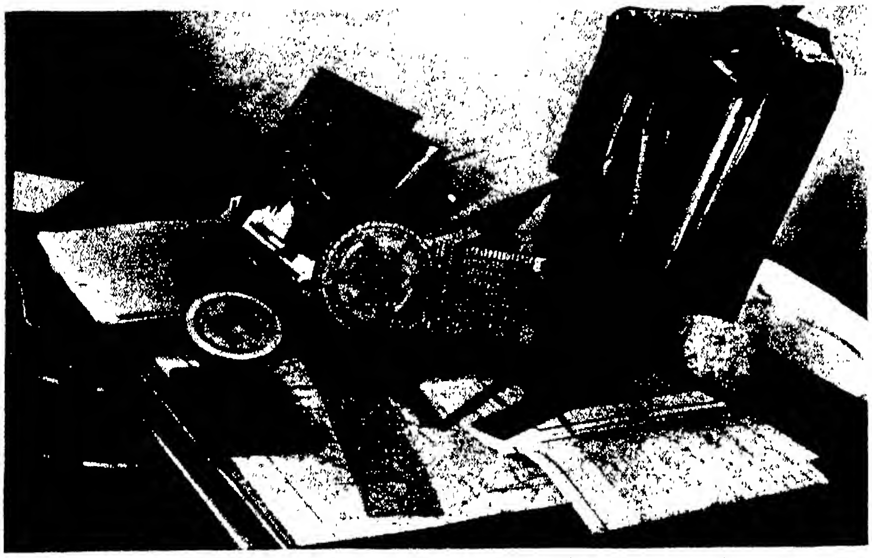
WHEN traveling through the air at speeds of 200 miles per hour paint, wood, fabric or even metal parts of a plane are abraded by rain and hail. Rubber absorbs the force of these blows and as a result is not destroyed. Rubber abrasion shoes have been placed over these exposed surfaces and are entirely satisfactory.

Sound and Aircraft

ANYONE who has heard an Army airplane pass over head will remember the peculiar sound which it produces, and which is mainly due to the propeller. The airscrew produces sound of a higher intensity level than the engine, and hence the motor and exhaust remain relatively inaudible. As the airplane speeds away, the noise subsides to a boom or steady roar. As it returns the boom is supplemented by the higher pitch sounds, and renews its piercing qualities.

At the Langley Field conference there was recently given a splendid and highly scientific demonstration of these phenomena. An electrically driven airplane propeller was placed in front of a microphone and connected through an acoustical filter to an amplifier. The filter was manipulated to "band pass" various frequencies with sharp definition. When all the frequencies developed were allowed to pass through the filter, one heard the sound of the propeller precisely as if a squadron of single seater fighters were passing through the air. When the higher frequencies were filtered out, the audience had the impression of airplanes flying away, as the noise gradually passed into the booming roar. Then as the higher frequencies were again passed through the filter, one felt that the airplanes were approaching once more.

This method of simulating approach and departure is readily explained. The propeller gives out noises of every frequency between zero and several thousand cycles per second. The lower frequencies represent the



The equipment that is carried by the pilot of a transport plane

"rotation noise," dependent on the revolutions per minute and the number of blades striking the air. The "rotation noise" is of the character of sound waves which pass through the air without dissipation, though of course with lowering of intensity by distance. The higher frequencies are due to the shedding of vortices from the tip of the blades (analogous to the tip vortices at the tip of an ordinary wing), and these vortices are rapidly dissipated as they pass through the air. Hence the "vortex noise" is not heard so far away as the "rotation noise." —*A. K.*

The Transport Pilot's Kit

THE Chief Pilot of a modern airliner begins to resemble the master of an ocean liner in his duties, training, and equipment. With the automatic pilot to relieve him of much of the fatigue and boredom of long-distance flights, he can now turn flying into a really scientific profession. Our photograph shows the equipment which such a pilot now carries in a leather bag. Included is a profile map showing the elevation of all points on the course, together with the radio beam stations and courses. A computer is used for calculation of ground speeds, wind drift and velocity, and gas consumption. At the bottom of the photograph is shown a protractor, used for determining the true course as laid out in advance of the flight. Radio range maps, drift tables, tables showing cruising speeds necessary to make schedules, company orders, Department of Commerce regulations, and so on, are all included in this paraphernalia.—*A. K.*

The Robot Plane

THE *Queen Bee*, the British "robot airplane," has created quite a sensation on both sides of the Atlantic. On its first flight, with the pilot in the cockpit not touching a single plane or engine control, but merely going along as a precautionary measure, it took off, performed every sort of evolution and landed—all under remote control. A robot airplane has obvious possibilities for target practice by military pilots and by anti-aircraft gunners on the deck of a battleship. We can also conceive of the robot as a weapon of attack, carrying a heavy load of bombs and dealing destruction to a battleship or a city without risking the life of a single pilot.

As shown in the photograph (for which thanks are due to the Society of British Aircraft Constructors) the Tiger Moth light biplane, with a 130 horsepower Gipsy engine, offers no particular interest. There is nothing exceptional about the performance of the machine. Under perfect radio control it can climb to a height of 10,000 feet, reach a speed of 100 miles per hour and fly, until the fuel gives out, to a distance of about 10 miles from the operating center. The airplane has catapulting points for launching, and a fixed aerial.

The rear cockpit carries the really interesting control mechanism and with regard to this the British are naturally secretive.

Remote control is by no means new. John Hays Hammond, Jr. thus "drove" a small motorized box-on-wheels years ago. Dr. Hammond has also succeeded in directing a torpedo by wireless. During the War we remember seeing a remote controlled automobile riding around the Army Air Station at McCook Field, Dayton, Ohio, without an occupant and doing remarkably well. The present experiments seem to constitute an improvement in precision and flexibility. What are the secret methods employed?

Thanks to the aid of Lt. Myron F. Eddy, expert on aircraft radio, we can make the following conjectures about the new ship.

As is well known, a radio receiving circuit can be so constructed that it will respond to only one frequency, and a transmitter can be so built that it will send out only one frequency. With short wave radio, tuning is possible within a very narrow band, which makes for the closest coordination between transmitter and receiver.

The newspapers report that the officer in charge issued the following commands in rapid succession: "Left, Dive, Right, Straight, Level, Glide, Climb." It would seem therefore that about seven coordinated electrical systems would be sufficient for complete control. We can imagine on the ground a control cabinet with seven switches, therefore, each switch putting into action an electrical system corresponding to the above commands. When a particular transmitter comes into play, the corresponding receiver through an amplifying relay actuates either an electric motor or perhaps opens a valve in a hydraulic system. The electric motor or the hydraulic piston, through a readily imaginable control system (probably not dissimilar to the usual control system of an airplane), actuates the elevators, rudder, or ailerons in appropriate fashion.

Of course skill is needed for such a design, but any competent electrical engineer working with a mechanical aeronautical specialist could probably achieve a similar apparatus without much trouble—once it has been shown that the idea is practicable, of course!—*A. K.*

Packages by Air

MOST of us know that there is a Railway Express Agency which handles packages for the railroads, but it is not so generally known that this Agency has an Air Express Division, with some 120 special offices for the handling of packages to be sent by air. This branch of express work is growing very rapidly, and its scope is almost unlimited. Everything can be shipped by air except inflammables, explosives, and live-stock. Nor is it a question of just small parcels. Packages up to 200 pounds, and 106 inches long are carried regularly. Even heavier packages can be sent by special arrangement. Parcels can be sent from anywhere to anywhere.

Ordinary packing, automatic insurance, and, above all, speed are what the Air Express Division has to sell. Huge presses have been set in motion by the speedy ar-

There is nothing mysterious in the appearance of the British "robot" plane

rival of an electro by air, serums and instruments have been flown 2000 miles to save a patient's life, corporation records have arrived in time to swing a big deal.

Here are typical rates and speeds: Los Angeles to New York, 21¼ hours, one pound for $1.74 and 10 pounds for $10.20; Chicago to New York, five hours, at $1.25 a pound or $3.44 for 10 pounds. No wonder that the Boeing 247 has provision for packages with a total weight of 1050 pounds in its nose, and a special package compartment in the rear of the passenger cabin. —*A. K.*

Small Samples for Clever Chemists

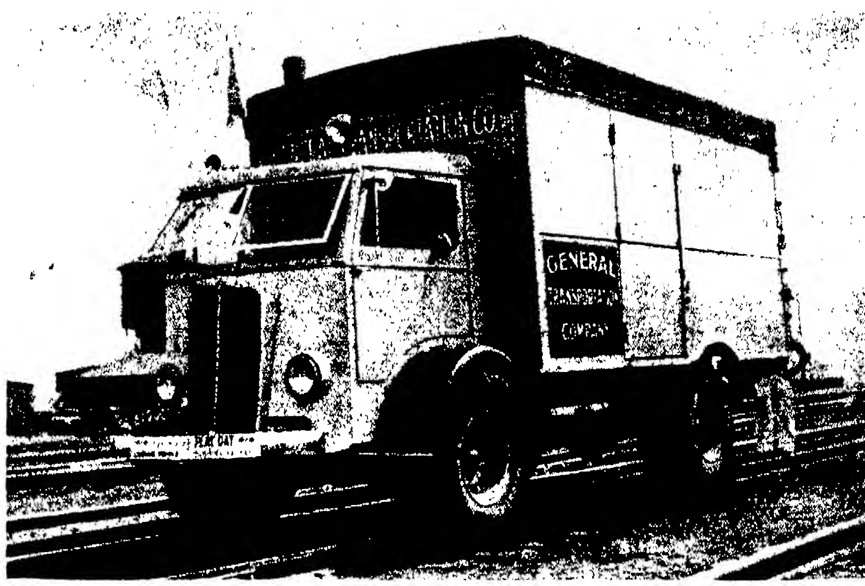
How the chemist analyzes a sample of metal so small that it has to be gathered up in a drop of oil is described by Beverly L. Clarke and H. W. Hermance, of the Bell Telephone Laboratories, in *Industrial and Engineering Chemistry.*

Contact points of various metals and alloys are widely used in telephone apparatus, as in relays and switches. Rapid qualitative analyses are frequently required to identify the alloy. Usually only a single contact is available and this must not be destroyed. Sufficient sample for a qualitative analysis is obtained by drawing the metal across a roughened spot on a microscope slide. The resulting streak is dissolved in acid, transferred to a clear glass slide and evaporated. Identification of this residue is made by reactions carried out under the microscope.

If the quantitative analysis is desired, samples may still be removed without destroying all of the contact point by means of a dental engine using a tiny rounded burr. The operation is carried out under the microscope, the fine particles of metal being retained by a drop of oil from which they are subsequently recovered by centrifuging and washing with a suitable oil solvent.—*A. E. B.*

Kitchen Modernity

How the plumbing industry is providing the impetus for a revival of building activity through the creation of new style-appeals in the kitchen is shown by the accompanying view of a model kitchen exhibited in Chicago recently by the plumbing division of the Briggs Manufacturing Company.



The road-rail truck during its recent trial run

The kitchen cabinet sink is an example of drawn metal construction which has started a new trend in plumbing style and utility. The sinks are available in any color or color combination desired. The enamel is acid resisting. The small unit at the left of the sink is a dish washing machine developed by the same company. At the right of the sink is their new styling of a refrigerator.

In the foreground is a round electric stove which was created by engineers as a suggestion to the industry. The stove rolls on castors and permits cooking from any angle.

Road-Rail Truck in Successful Test Run

A new rail-highway motor truck recently made a successful test run from Akron to Cleveland over the Baltimore & Ohio railroad tracks, turned off the rails at West Third Street and then proceeded to its destination.

The truck, made by the Hendrickson Motor Truck Company for C. C. Nugent of the General Transportation Company, Boston, Massachusetts, developer of this road-rail truck idea, has combination wheels which carry special truck tires, developed for this purpose by Goodrich engineers, mounted beside steel flanged railway wheels.

The truck is driven on the rails at any crossing. The rubber tires are then deflated, so that the truck settles down with its steel wheels on the tracks. The front wheels are locked when the truck is on the tracks and the driver has no steering to do.

When the truck arrives at its rail terminus, tires are inflated simultaneously from the engine by the same air system that is used for brake operation.

New Radiator Cleaner

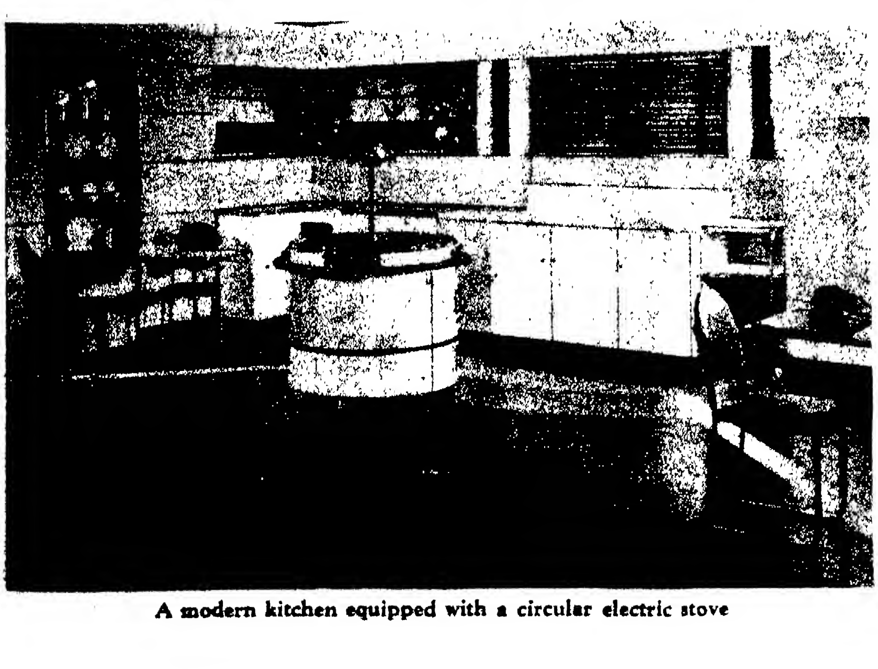
A new automobile radiator cleaner that exhaustive tests show will not rust or otherwise damage aluminum or aluminum alloy or other metal parts in auto motors or radiators has been developed by the Du Pont company. Many of the more modern motors use aluminum as a part of their cooling system.

Tests show that permanent spots will not develop on lacquer, baked enamel, or chromium if this cleaner drops on them. Chemists even boiled chromium-plated metal and aluminum and aluminum alloys in a solution of the new cleaner, but found no tendency even to spot the metals.—*A. E. B.*

Inheritance of Pigmentation

The question is constantly asked whether or not parents who are light in color, that is, one of whom has a small amount of Negro blood, may give birth to a coal-black child. Indeed, newspaper stories of the birth of a black child to white parents whose ancestry shows a slight trace of Negro blood several generations back appear with amazing frequency. The question is also asked whether or not pure Negro children may be born to mulatto parents who occasionally pass as white. The answer is of course in the negative.

The entire subject was analyzed by Irene Barnes (Barnes, Irene: The Inheritance of



A modern kitchen equipped with a circular electric stove

Aluminum paint is being used on the San Francisco-Oakland Bay Bridge

Pigmentation in the American Negro, Human Biology 1:321 [Sept.] 1929), who was concerned particularly with the question of whether or not the crossing of persons of different color results in a blend of pigmentation.

The conclusions reached were that the offspring of parents of different color tend to resemble the parent with the greater percentage of dark pigmentary supply more than they tend to resemble the parent with the less percentage. However, pigmentation is not inherited by blending nor is it produced by the action of one or two factors that act as mendelian dominants. The studies made by the Davenports indicate that two nearly white hybrid parents can have offspring somewhat darker than themselves but that it is not genetically possible for non-hybrid parents to have Negro children unless a melanic mutation should occur. There is no evidence that such mutations do occur, and the appearance of a Negro child from a white parent naturally has a much simpler explanation.—*Journal of the American Medical Association.*

Aluminum Paint for Bridge

After more than two years of debating, architects and engineers have finally agreed on aluminum paint as a final coating for the new San Francisco-Oakland Bay Bridge; in fact, painters are already at work on the giant span.

The principal paints under consideration were black, gray, and aluminum. Architects favored gray from an appearance viewpoint; engineers preferred black because of its durability. A happy compromise was found in aluminum, which is satisfactory from an appearance viewpoint, and at the same time possesses durability equal to black paint.

The complete paint system for the bridge involves several paints. Over the bare steelwork go two coats of rust inhibitive red lead, followed by an intermediate base coat of black graphite paint. The aluminum field coat concludes the job. This system, in the opinion of paint experts and engineers, will furnish a fool-proof coating that offers maximum endurance with a minimum of maintenance worries, at the same time presenting an attractive appearance from all viewpoints.

Synthetic *vs.* Natural Camphor

Unlike synthetic indigo, which long since supplanted the natural product, synthetic camphor, although a comparable triumph of organic chemistry, runs nip and tuck with the natural camphor. Only by virtue of a protective tariff can American synthetic camphor compete with the natural product. Uncle Sam has imposed an import duty of five cents per pound on natural camphor, but has warned the synthetic manufacturers that they must produce more than one half of the domestic camphor used, or lose the benefit of this protection.

The United States Tariff Commission has checked up the figures for the first six months of 1935, and found that more than half of the camphor used in the United States is of the synthetic variety.

New Cutting Edge Welded on Worn Tools

A new arc-welding electrode which is designed for restoring worn cutting edges on tools of all kinds and which is said to permit savings of 20 to 25 percent in tool cost is announced by The Lincoln Electric Company. This new electrode, known as Toolweld, is the product of several years of research. By using this electrode, lathe tools, bits, milling cutters, drills, cutting and forming dies, and all other tools which have become worn in service can be given a new and harder cutting edge than has heretofore been possible. Tools can be refaced an unlimited number of times, and new tools, using ordinary steel in place of high-speed steels, can be provided with a cutting edge at tremendous savings.—*A. E. B.*

Intense Sound Makes Milk More Easily Digestible

Make a loud enough noise at milk and the baby will digest it more easily. That, in effect, is the discovery reported by Dr. Leslie A. Chambers of the University of Pennsylvania. Dr. Chambers spoke before the American Dairy Science Association, meeting jointly with the American Association for the Advancement of Science.

The apparatus used in the experiments consisted of a heavy steel diaphragm, driven by an oscillating electric current. Similar devices are used for submarine signalling. Over the diaphragm Dr. Chambers flowed a thin stream of milk, while he caused it to vibrate very strongly at various rates. The lowest vibration rate he used was 360 cycles a second, which is the pitch of F-sharp in the middle of the piano keyboard. The highest rate was 3000 cycles a second, about three octaves higher than middle F-sharp.

The effect was to alter the curd-forming character of the milk. Whereas the milk used normally formed a hard curd, difficult to digest, when acted upon by the pepsin of the stomach, after treatment it formed a soft, easily digested curd. Soft-curded milk is especially desirable for feeding babies, as well as older persons with "weak stomachs." Some cows naturally produce soft-curded milk, but many do not. Dr. Chambers' experiments have demonstrated a simple mechanical method to make soft-curded milk at will, out of any kind of milk.—*Science Service.*

Insulating Cement

A new insulating cement known as Sonittep, useful for both high-and-low temperature insulation, which can be applied both to hot and cold surfaces, has recently been developed by George F. Pettinos, Inc., Philadelphia, Pennsylvania. The cement requires no reinforcement and withstands temperatures to 2000 degrees, Fahrenheit. It is said to be reclaimable when used at temperatures not exceeding 1400 degrees, Fahrenheit. The cement is shipped dry and requires only the mixture of water for application. A quantity of 1000 pounds of cement will cover 50 square feet to a

Courtesy *Nature* (London)

Four echo records, showing the presence of spawning cod. In each instance the lower dark line represents the bottom of a fjord—its upper edge the mud bottom and its lower edge the rock. Spotty, horizontal areas higher up represent fish

depth of one inch, and can be applied by unskilled labor. It is said to have about three times the covering capacity of asbestos cement and four times the insulating value, showing a heat transmission considerably below that of 85 percent magnesia.—*A. E. B.*

Echo-Sounding Apparatus Finds Schools of Fish

ECHO-sounding apparatus, now widely used on ships to make continuous records of bottom depth, can also be turned to good account in the fisheries industry in locating large schools of commercial fish.

In a letter to the editor of the British scientific weekly, *Nature*, Oscar Sund, well-known Norwegian fisheries scientist, reports four instances when the apparatus on the research vessel *Johan Hjort* disclosed the presence of large numbers of codfish spawning in midwater. The records demonstrated clearly the hitherto unsuspected fact that when codfish lay their eggs they pay no attention to the bottom, but maintain a position at a uniform depth beneath the surface.

Sound waves sent out from the ships' bottom were reflected off the fishes' backs and returned to the listening device just as they do from the rocks or mud of the sea bed. The length of time between the start of the sound and its return as a submarine echo indicates the depth.—*Science Service*.

Dr. Sund's letter is as follows: "The vessel used for the annual oceanographical investigations in the Lofoten area (the *Johan Hjort*) had a Hughes echo sounding gear (magnetostriction system, frequency 16,000 cycles per second) installed before leaving Bergen last February. The gear worked smoothly all along the coast and besides furnishing a great number of interesting sections, revealed many features hitherto unsuspected; among others, that the clay flooring of deep fjords is invariably about 10 meters thick and generally very flat.

"Marks referable to fish were seen on the record only after the arrival at that portion of the Lofoten fishing area where the most prolific fishing has been going on during recent years—at Hola—a bight of the West Fjord of very restricted dimensions, say, ten miles by four miles. At this place fish were indicated continuously along straight courses of two nautical miles and more. The nature of the indications may be seen from the photographic reproduction of four separate records, partly obtained while the ship was stationary among the hand-line boats, which got the fish exactly at the depth indicated.

"It is interesting to note that this spawning concentration of cod has apparently no relation to the bottom. This was well known before, but no one could have imagined the fish to be limited to such a sharply defined layer of only 10-12 meters in thickness, extending widely above deep water and shallow, always at the same distance from the water surface. This distance was 72 meters at the first encounter with the spawning shoals (March 11) and 50 meters at the conclusion of this investigation on April 5. Concurrently, the temperature in the 'fish' waterlayer had decreased from 6·5 degrees - 6·0 degrees to about 3·0 degrees, Centigrade. In some instances a perceptibly lower oxygen and hydrogen ion concentration was observed in this water-layer than in the layers immediately above and below."

Filter for Home Water Systems

CHARCOAL has long been used for a great variety of purposes in connection with sanitation and cleanliness. It has remained, however, for the K. & S. Foundation, Inc., to adapt to the home water system the properties of charcoal for adsorbing foreign particles, gases, and even smells. The equipment they have developed is the essence of simplicity, as it is essentially a tank filled with charcoal, through which city water flows in its passage to the various faucets. The important point about this equipment, however, is a patented feature which provides for back-flushing the charcoal periodically to remove accumulations of sediment or unwanted chemicals which enter the house from the water main.

In operation—referring to the accompanying illustration—water enters from the right, passes through the tank full of charcoal, and out into the house system, through the pipe at the left. At rather long intervals, water is by-passed through the pipe paralleling the tank, so that it enters at the left end, back-flushes, and drains off to the sewer, through the pipe line at the bottom.

This filter produces crystal-clear water for all household or industrial purposes, for it removes all suspended organic or other matter that would adhere to the inside of the pipes, or which would produce malodorous or discolored water. It does not, of course, take care of bacilli, but in city systems such additional control would not be necessary. The size of the filtering compartment varies, according to the quantity of water used, from 12 by 36 inches to 24 by 96 inches.

"MINING" DRY ICE

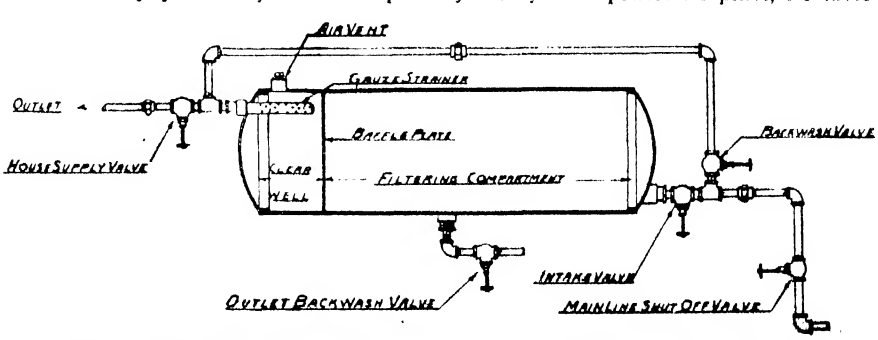
CARBON dioxide is reported to underlie the Salton Sea basin in southern California. From the 35 billion cubic feet of this gas reported in this area, nearly a million tons of dry ice could be manufactured and probably will be at some future date.

Debunking Man-Eaters

MAN-EATING sharks there may be; man-eating alligators there are not. "I know of but one authentic instance of an alligator wilfully attacking a human being unprovoked," declares E. A. McIlhenny, Louisianian who has lived among the big reptiles all his life and now has written a book about them, "The Alligator's Life History."

Mr. McIlhenny makes one qualification: females guarding the hidden nests where their eggs are laid. "Female alligators will attack man to protect their nests and young, but their movements on land are so slow that there is no trouble in avoiding them, and in the water they always give warning if they are about to attack, by hissing and guttural grunts.

"It is a wonder more men are not injured by these powerful reptiles, for those



Later models of this water filter place the outlet backwash valve at the right

who make a business of hunting them for their skins are most careless in handling them; but it is a rare thing for any one to be hurt by an alligator."

But what of the many reports of alligator attacks ending in severe injury to human beings? Fish stories, literally, says Mr. McIlhenny. There is a big, vicious, long-jawed, sharp-toothed fish in the southern lakes and bayous, known as the alligator gar. It has all the strength and truculence of the muskellunge of the north or the barracuda of the warmer salt waters. Several cases of injury and drowning alleged against alligators have been investigated by Mr. McIlhenny, and an alligator gar turned up as the culprit in each one.

When he and his childhood companions were in swimming, they entertained themselves by "calling" 'gators to surround them. "We would attract them by imitating the barks and cries of dogs and by making loud popping noises with our lips. . . . We had no fear of them and would swim around the big fellows, dive under them and sometimes treat them with great disrespect by bringing handfuls of mud from the bottom and 'chunking' it in their eyes."—*Science Service.*

Useful Derivative of Sugar

CANE sugar becomes a raw material for the chemical industry with the introduction of a compound useful in waterproofing and in making molding resins. The new compound, introduced by the Niacet Chemicals Corporation, is known as Sucrose octa-acetate and is announced as the first of a series of derivatives utilizing cane sugar as an industrial raw material. Sucrose octa-acetate is a white, crystalline substance, soluble in a wide range of common organic solvents—a property which gives promise of many applications. For instance, when cloth is wet with a solution of this substance, then ironed, it acquires a glossy, water-repellant surface. Sucrose octa-acetate is also used as a resin plasticizer, in molding resins for electrical parts, for waterproofing insulating paper, and so on.—*A. E. B.*

FLY GERMS

THE average number of bacteria carried by a fly was placed at more than 1,000,000 in an investigation by two scientists who recently examined 400 house flies.

Tantalum Sheets .005 Inch Thick Are Arc Welded

TANTALUM sheets worth 50 dollars a pound and so thin that it takes 200 of them to make an inch are now being arc welded regularly in the fabrication of chemical equipment.

Exacting requirements covering the articles fabricated from tantalum have made it necessary to develop a special technique for welding it. The method finally adopted consists of first forming a straight angle flange at all edges of the sheets to be arc welded. These flanges are then fitted to-

gether and tack welded in a few places to avoid shifting the assembly. The job is then immersed in a tank filled with carbon tetrachloride so that the edge to be welded is approximately ¼ of an inch below the surface of the liquid.

Immersion in carbon tetrachloride requires higher voltage across the arc than would be needed to weld in air, and at the same time, the thinness of the stock being welded and the necessity for strict localization of the heat demand low welding current. Hard carbon electrodes ⅛ inch in size, held in small light electrode holders, are used.

The welding process was developed by Fansteel Products, Inc., using Lincoln Electric Company equipment.

Safe Lock for Open Doors

A NEW type of emergency door lock—"Safety Catch," manufactured by The Kawneer Company—is a decided improvement over the old-fashioned chain or bar lock. It is inexpensive and inoffensive yet gives positive protection against unwelcome intruders. The photographs show how it is attached to the door and floor and operated by the foot.

FAMOUS LIGHT-WEIGHT

ALUMINUM is about one half as heavy as vanadium and yttrium, one third as heavy as iron, copper, and tin, one fourth as heavy as silver and lead, one fifth as heavy as mercury, one sixth as heavy as tantalum, one seventh as heavy as gold, and one eighth as heavy as platinum.

Increased Use of Soya Bean Oil

EVIDENCE of the growing commercial importance of soya bean oil is found in the fact that approximately one sixth of the total yearly production of 37,200,000 pounds of soya oil was utilized for edible purposes. Refined soya oil, produced by modern methods, is a valuable source of vitamins A and D; a source in which vitamin D is not formed artificially at the expense of the vitamin-A content.

Refined soya oil is used mostly as a substitute for salad oil, often being blended with other oils. In this country it has recently found a new outlet in the mayonnaise industry.

The domestic consumption of soya oil in

Left: The Safe Lock for open doors in operating position. _Below:_ The latch is pushed out of the way when not in use

the production of margarine amounted in 1918 to nearly 6,000,000 pounds; in recent times it is again gaining in popularity as the interest for margarine in this country is rapidly developing.—*A. E. B.*

Ice Lowers 'Phone Subway Line

IF anyone had investigated the excavations in Flatbush Avenue, Brooklyn, adjacent to the Floyd Bennett Airport, on a certain night during last spring they would have seen a long and massive line of telephone conduit apparently reposing peacefully there, with the companionship of the night watchman as he made his rounds to adjust the red lanterns.

But things are not always what they seem and what appeared to be a most inactive piece of telephone subway was actually in the process of being lowered several feet. Weighing 60 tons, a 500-foot section of nine-duct tile conduit, with a concrete slab under and on top of it, in addition to two creosoted wood ducts and two maximum sized cables, was moving downward in strict accordance with the wishes of the telephone construction engineers and workers. Here's the answer: Ice!

Massed ice, for lowering heavy, compact structures of great strength has been used in other construction fields before, but never for long, fragile structures such as telephone conduit.

The methods previously used in lowering duct lines employed blocks, screw jacks, or chain hoists, supported from timbers or tripods, attached to slings placed around the conduit every few feet throughout the section to be lowered. By operating these devices the tile ducts with their brittle mortar joints and concrete base and top were lowered more or less evenly to their desired position. These methods required a large amount of lumber, equipment, and labor and resulted in breakage of tile, mortar joints, and concrete.

The work leading up to the use of ice consisted first of excavating to uncover the conduit in its original position, then of digging under it at intervals of about six feet to provide pits for ice, next placing the ice and then removing the earth remaining beneath the conduit between the pillars of ice. After that there was nothing to do but wait for the ice to melt, which requires about two days. During this period the next section was being prepared and the preceding section back-filled. Some sections were lowered to as much as 48 inches and in these deep places the work was done in two or three stages, depending on the depth desired.

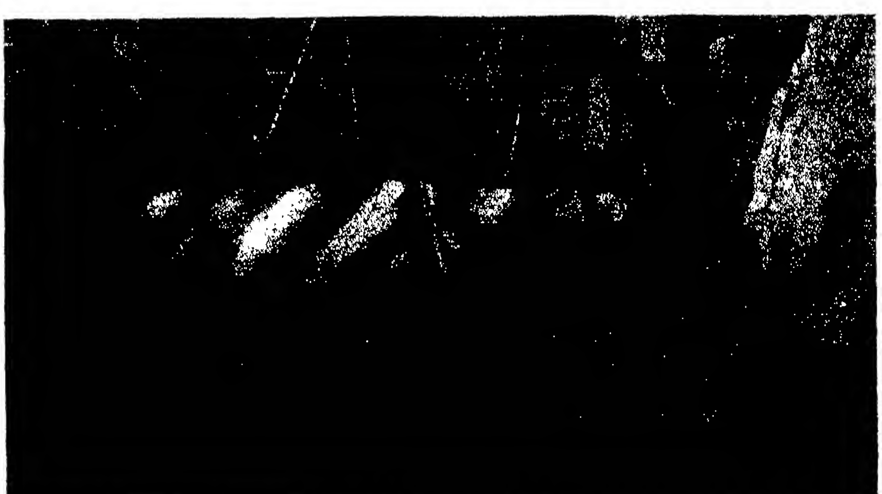
Ordinary commercial cakes of ice were used. The iceman delivered the pieces alongside the trench and cut them into blocks suitable for placement under the conduit.

A total length of 3200 feet of telephone subway was lowered by this method, not only resulting in a substantial saving but also in protecting an important section of the telephone equipment from possible breakage or interruption of the service.

Rancidity-Retarding Cellulose Wrapper

AN interesting display was recently passed on to us for examination. This consisted of a hand-made light-retardation tester, composed of a sheet of sensitized photographic paper over which were pasted strips of several pieces of cellulose wrapping in different colors, and other wrapping materials such as parchment, glassine, and wax-paper. This little device showed a wide difference between these materials in ability to transmit the rancidity-causing rays of light.

For some time it has been known that light is deleterious to many food products. It is for this reason that some foods are now packed in green bottles, and many medicines are in brown. The most remarkable



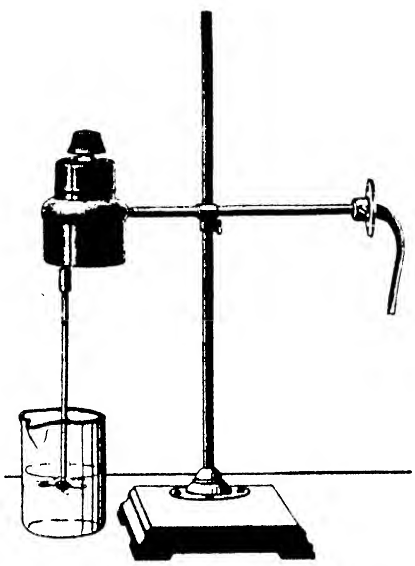
Ice being used to lower a 'phone subway line into place

fact about the exhibit above mentioned is that one cellulose wrapping material retarded these harmful rays more than even the green, and yet gave perfect visibility, and added attractiveness, to the food wrapped within. This is a new product, called Old Gold Sylphrap.

Thus, in this we find a rancidity-retarding material which at the same time creates an attractive and salable package. It is claimed that such products as potato chips, which ordinarily become rancid in two days in colorless transparent wrappers, are preserved in this new material for 30 days or longer.

Electrical Laboratory Stirrer

A FOOL-PROOF laboratory stirrer, just released, is a sturdy, well built accessory useful for making emulsions; dissolving dyes, gums and resins, waxes and bitumens, pyroxylin, cellulose ethers, casein,



Stirrer for the laboratory

glue, gelatin, starch, salts; extracting crude drugs and herbs, oil seeds, complex organic materials, and so on.

Actuated by a shaded pole type motor (110 volts, 60 cycle), it will run 24 hours daily without damage. It is non-sparking and will not be injured by fumes and vapors. The speed may be varied as needed by the rheostat. It fits an ordinary clamp holder or may be screwed to a shelf or wall. The shaft and propeller are furnished in chromium plate or Monel. A flexible, six-foot rubber covered cord and soft rubber plug are included.

Black Widow Spider Not As Black As She's Painted

NOT as black or deadly as she has been painted is the latest medical verdict on the black widow spider. This partial clearing of the lady spider's reputation is made by Drs. J. M. Frawley and H. M. Ginsburg of Fresno, California, in a report to the *Journal of the American Medical Association*. Fifty-two cases of black widow spider bite have been treated without a fatality in the Fresno General Hospital, these doctors

(*Please turn to page* 215)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

THERE ought to be some definite, quantitative way which would enable the amateur telescope maker to measure, also to express to others, the hardness of the pitch used in laps for polishing lenses and mirrors. Just how hard is a "soft" pitch lap, and how soft is a "hard" lap? The old hands know the answers, but how is the poor isolated beginner to get a clear idea? As a result, many flounder along for months or years before discovering that their pitch has been too hard or too soft—generally the latter. Here is a colloquy we dreamed one night:

Anxious Beginner: "How hard ought a pitch lap to be?"

Seasoned Old Hand: "Well, not too soft, or else it'll turn the edge."

A.B.: "Yes, but just exactly what do you mean by 'too soft'?"

S.O.H.: "Why, it ought to be quite hard."

A.B. (still cherishing hope of getting a definite idea that will help): "How would you define 'quite hard,' then?"

S.O.H.: "Well—aaaa, hard enough so it won't turn the edge."

A.B. (beginning to perspire): "But isn't there any *exact* way to pin it down to definite terms—as you know, I'm only a little fella, working all alone."

S.O.H.: "Yes, you may chew the pitch and judge it that way. You bite down on it, slowly but not too slowly, and not too fast, and if it 'gives' too fast it is too soft, but if it shatters, unless you have bitten too fast, it is too hard. Then another way is to test it with your fingernail. Press quite hard for quite a time, and if the mark is quite long the pitch is probably quite soft, but if it is quite short it may be quite hard. That's all there is to it—it's simple enough."

This situation has led Joseph A. McCarroll, 521 Palisade Avenue, Teaneck, N. J., to design a pitch tester. Through the common use of such a machine, workers may now, wherever they are, compare pitch hardness in definite, quantitative terms which will mean the same to all from Maine to California, and from Edmonton to Brownsville. A photograph of McCarroll's tester is shown on this page. It is a simple rig, easy to build, and one ought perhaps to be made and kept available at least in every club group. Making one is not much of a task. And here, for once, we favor "standardization," for without standardization of the essential specifications of the little tester the end sought would be defeated. It is not, however, necessary to standardize the materials from which it is made, or the color of the paint on it. McCarroll writes:

"The principle of the test is the penetration of the pitch by a needle of specified dimensions, under a certain weight for a certain length of time and at any given temperature. The test is in all respects similar in principle to the 'Standard Method of Test for Penetration of Bituminous Materials,' as adopted by the American Society for Testing Materials, 260 South Broad Street, Philadelphia, Pa. The standards of this society are 'standard' throughout the entire country, in the engineering professions and in industry and commerce generally.

"The pamphlet issued by the Society is known as 'A.S.T.M. Designation D5-25.' A copy may be obtained from the Society for 25 cents. This pamphlet includes a description of a needle (smaller than the one to be described here) and an outline of the conditions under which the test shall be conducted. It does not describe any machine. That is left to the ingenuity of the inventor. The responsibility for the design of the machine shown on the present page must rest with me. The credit for making a really workmanlike gadget of it is due to Mr. Frank Wanderer, a member of our local A.T.M. association.

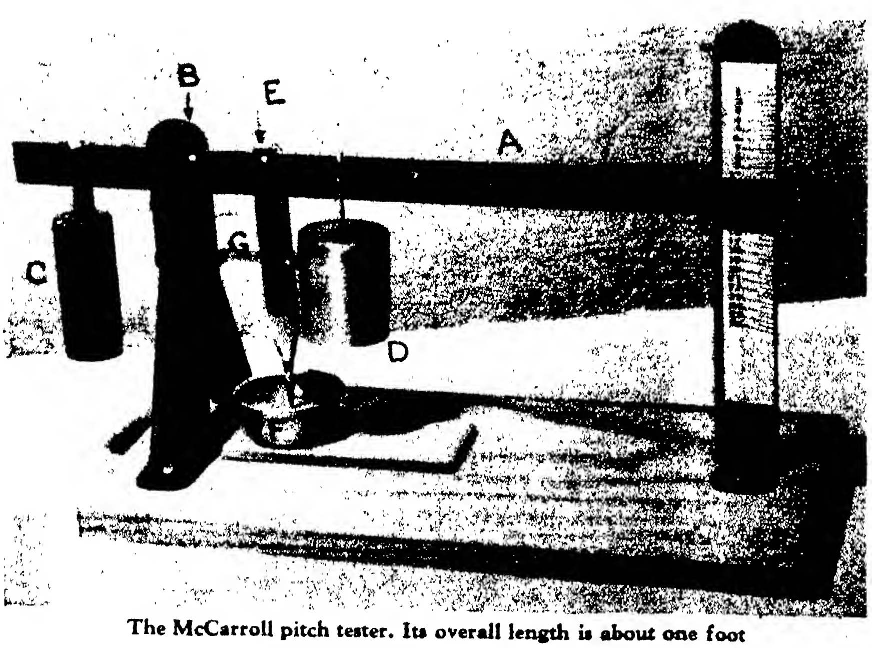
"The machine shown was made of thin, cold-rolled steel. Aluminum would be better. The arm *A* is 13 inches long and is provided with a guide piece, so that its end straddles the scale post at the right. It works on the principle of the lever. The arm is balanced on the supporting pin *B*. It is counterbalanced by weight *C*. The 1-millimeter needle, supported at *E*, is separated by a $1\frac{1}{4}''$ space from *B*. The one pound weight *D* is shown resting in a notch which is the same distance from *E* as *E* is from *B*. This gives a pressure on the needle of two pounds, and each successive notch, separated by the same distance, adds a pound to the applied pressure, as shown by the numbers on the lever. The scale is graduated in actual degrees of arc, with center at *B*.

"*F* is a small pan. It contains one half inch depth of pitch. The pitch is allowed to cool to room temperature before a test is made.

"In making the test the sample of pitch is set in place, the needle adjusted, the weight *D* held in the hand, the temperature noted, the time observed, and at the word 'go' the weight is gently hung on at the two pound notch (usually) and the downward swing of the lever in one minute is recorded. If the sinkage is about three degrees on the scale (using coal tar pitch) with two pounds pressure for one minute, I regard the pitch as medium soft, and suitable for making a lap for general polishing purposes. The specific hardness under these circumstances might be said to be '2P3D,' meaning two pounds pressure and 3° deflection of the lever. The temperature has no significance in connection with *specific* hardness, for the pitch must be, say, 2P3D at whatever the workroom temperature is, and if the temperature should rise five degrees it would be absolutely necessary to use a pitch of higher melting point in order to have the test show the *same hardness.* Any appreciable change in temperature will show in making a test.

"However, if one wishes to describe the *general* hardness properties of the pitch, it is necessary to specify the temperature

Porter with Dr. J. A. Anderson, executive officer for the 200-inch



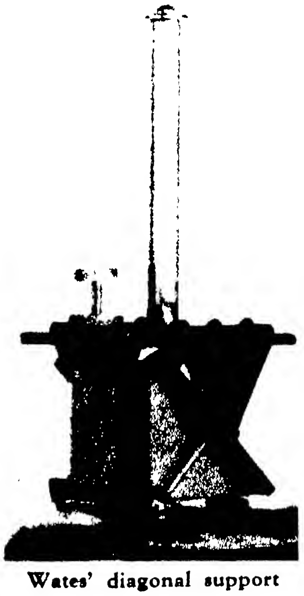
The McCarroll pitch tester. Its overall length is about one foot

at which the test is made. This will show the relation to the melting point of the pitch, which should be known in order to facilitate tempering operations, and, of course, for a complete specification of the character of the pitch.

"The use of a scale graduated in actual degrees of arc makes it easy for the individual to design machines of different sizes, but with the same system of scale notation and needle size. The needle has a flat, round end of 1 millimeter diameter, tapering upward to 5 millimeters in a length of 25 millimeters. The fixed hook *G*, attached to the pillar and loosely embracing the needle, is simply for controlling the point of contact of the needle on the pitch.

"The intention has been to make something as simple as possible that will do the work expeditiously and as accurately as is needed. There are some mechanical features connected with the design of this little apparatus which might be improved, but they do not introduce any appreciable error in testing. For example, the pivots might have less friction. Also the needle does not keep in an absolutely vertical position while penetrating the pitch, but since a penetration of about 1/16" is about all that is ever required, it is obvious that this feature may be neglected. Better ideas for a pitch tester may be forthcoming."

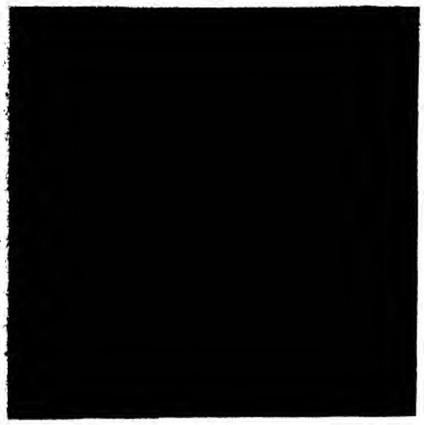
So much for McCarroll's description of a valuable device. The McCarroll tester gives



Wates' diagonal support

us a way to equate hardness with numbers, as in the one example mentioned—"2P3D." There still remains the gradual establishment of a general consensus regarding how many Ps and Ds of hardness a lap should have—general only, because this always will vary some with individual preferences. Note that there would be nothing here to compel, or desire to compel, any worker to conform to a standard set by others. The machine measures the absolute hardness of the pitch, and its terms are always the same for the same pitch at the same temperature. *A* may then say or write to *B*, "I like mine 2P2D," and *B* may reply, "Give me 2P4D." Each retains his pet hardness but each knows exactly what the other fellow means when he uses the common values of the McCarroll scale.

As a start-off, take a lap your scribe has



The Everest edge test: McGuire

just been using—made of coal tar pitch supplied by McCarroll. It was a rather hard lap at 70°, and was composed of two parts coal tar pitch with melting point 170° and one part ditto with 140° melting point. It was hard enough to permit easy maintenance of an unturned edge (by Everest's very critical diffraction ring test, ATM, p. 371) throughout polishing, and to keep a strong oblate tendency on the mirror. Everest tested this same lap by thumbnail and called it "hard" in terms of his own personal estimate. A sample of this lap, returned to McCarroll, was found to test 2P2½D.

THE picture of a diagonal support, which you saw on the preceding page, is one taken by Cyril Wates, 7718 Jasper Ave., Edmonton, Alberta, Canada, and is inserted with the hope that numerous others will send in similarly clear close-ups of diagonal supports. The idea is to make a collection and, some time hence, publish the lot of them together, since workers often ask us for ideas for designing such supports.

The same Cyril Wates is the one whose telescope is shown on the front cover. Those on the staff of this magazine who are responsible for selecting a front cover picture came to your scribe and begged for a good telescope photograph. About 100 unpublished telescope descriptions were gone over and this was the only one of the lot which would pass every artistic test. Not the telescope, though that, too, is arty enough, but the picture—clouds, river, and all the trimmings of good composition. In addition to the little note on page 169, directed to general readers, the following may interest telescope enthusiasts:

Wates' mirror has a 9-point suspension. He says "it is not quite true, as some old-timers say, that in this region we have 'nine months winter and three months bad sleighing,' but even the Orion nebula loses some of its charm at 30° below. In the summer, on the other hand, the sky is never really dark. On June 21, at midnight, the sun was only 14° below the horizon, and Vega was the only star visible to the naked eye in Lyra. But we also have skies of exquisite clearness, and a long, lovely autumn season." Wates will not learn, until he unwraps his "Sciam" in mid-September, that his picture is on the front cover.

WE have also been asked by L. J. S. to publish a collection of close-ups of Cassegrain secondary supports. Can't do it, unless we receive the pictures. Make them small-stop, long-exposure close-ups, glossy.

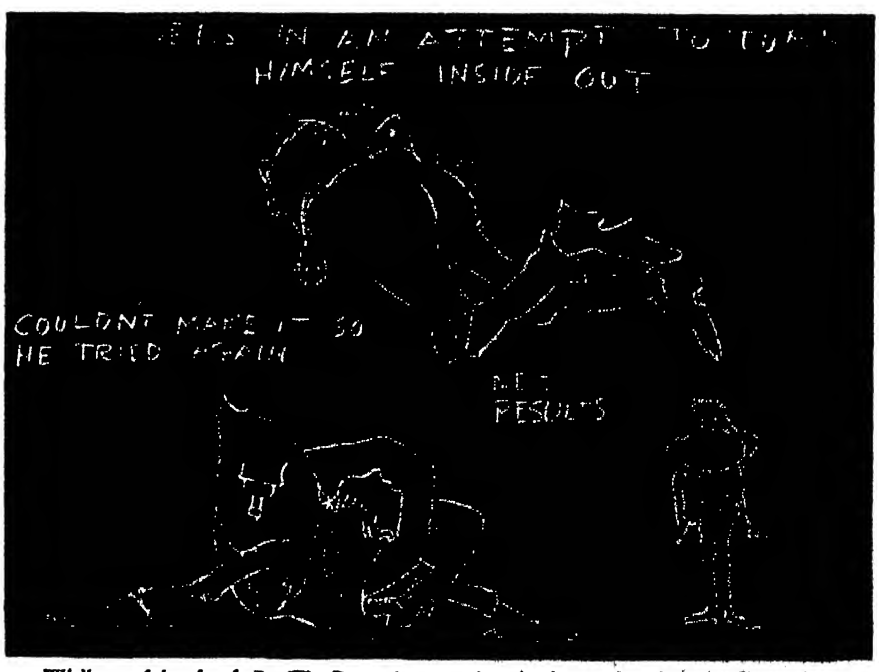
UP there in the northwest corner of this page is a sort of focogram of the Everest diffraction test described in "Amateur Telescope Making," page 371, made by Daniel E. McGuire, of Shadyside, Ohio, on a mirror which, as the test shows, does not have a turned down edge. Our reproduction does it some injustice, as the left-hand cusp of the ring should come out a bit stronger than it does. That test is probably the best of all the tests for turned down edge. Your scribe confesses not discovering it in A.T.M. until quite recently (must read that book, some time) and doubts whether many others have tried it out yet. Recently, on a mirror job, it was tried many times, in each instance immediately following the Ronchi test and the knife-edge test. It seemed to be the most critical of the lot. Do others find it so? Everest, who discovered the test itself, thinks a mirror which will pass it is mighty good—at least for edge. Any old mirror will easily show the right hand cusp; it is the one on the left that is wanted, but there will be a gap of an inch or so at top and bottom, even on a good mirror. McGuire's focogram, or diffractogram, shows the Everest straightedge, as explained in A.T.M. We have seen some mirrors whose left-hand diffraction cusp looked more like a photograph of a black cat, taken at midnight, in a deep dungeon, when the cat wasn't there. But a really swell mirror we gazed at for a long time, at Wally Everest's test rack in Pittsfield, Mass., showed the ring equally strong on either side. (That fellow has no respect at all for a fine mirror. Someone sent in a proposed new stunt for use of HCF, Everest was asked to give it a try, and chose this same fine mirror for the experiment, about ruining its figure. But he brings them back again, between a couple of smokes, and takes mirrors so lightly that perfect ones are used all over the Everest home as door weights. When bored, he picks up the nearest door weight **and turns it into something to envy. We sigh.)**

WE hear many rumblings and grumblings about eyepieces of the so-so kind—not very bad, not very good. Well, when a majority of persons tease a dealer to sell them "*good* but *low-priced* eyepieces," what can the dealer do? We have now and then been asked where a high-grade eyepiece may be got hold of—one that will not pull a high-grade mirror down. Why not have Kirkham make you one to order, to suit your needs? His eyepieces are beginning to become famous in select circles. But they aren't low-priced—we hope they will always stay high-priced.

LAST month we carelessly reported Hindle as figuring his machine-made mirrors by hand, with small polishers, and now he radios: "I never use hand tools, but figure with part-sized tools machine driven." As Hindle is the outstanding exponent of the machine for the whole job, we guess we pulled a boner that time! Apology, then, to Hindle. We have here the manuscript of a full treatise, by Hindle, on all-machine figuring. Publication later.

Alexander Elan, 4806 Illinois Ave., N.W., Washington, D. C., asks us to broadcast to Washingtonians the call to organize a club.

IT turns out that the use of coal tar pitch for laps is far from new, though no one seems to have mentioned it to us before we inserted a note announcing its "discovery," two months ago. Even so, at the heart of our little "announcement" was not so much the fact that coal tar pitch laps give smooth surfaces but its hardness controllability, through using mixtures of hard and soft pitch, each at *known* melting point. By the way, coal tar pitch requires a little more care than pine pitch, in melting. Some which Stoy of Atlanta melted took fire, fell on his hand and cost him two months' time trying to save the member. When melting it in a can, be sure to melt an escape channel for gases down one side first.



While a friend of R. W. Porter's expatiated about the fourth dimension, hyper-space, and other deep stuff, Porter's facile pencil unconsciously wiggled

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 211)

report. The right hospital treatment will save the life of the person the black widow bites, they believe. No treatment or the wrong treatment may result in death.

Here are some details of the treatment they recommend: They put the patient to bed and apply iodine to the site of the bite. They require him to drink large quantities of water and of non-alcoholic fluids. They give him a hypodermic to allay the pain and a sedative to permit rest. Then they inject into his veins a solution of magnesium sulfate, more commonly known as Epsom salts. It is the latter treatment that is credited with relieving the abdominal cramps and the other severe symptoms that follow the spider's bite.

An intoxicated man has a poor chance of recovery, once the black widow has injected her poison in him. Nor should any person who has been bitten by this spider be given a drink containing alcohol. Infants or very small children may not recover from this spider's bite, these Fresno doctors believe, because the amount of poison from the bite is large in comparison with their small bodies and the victims go rapidly into convulsions.—*Science Service.*

"Polite" Explosions for Modern Coal Mines

Because large pieces of coal—the so-called "premium" variety—are more valuable than small ones, and in order to escape the fumes which hamper work and sometimes endanger life, certain coal-mining areas in Illinois and Indiana have discarded dynamite blasting in favor of compressed air. With the new equipment, the coal is "politely" pushed out of place by the air pressure.

The coal dust and chips which are broken out by the dynamite are difficult to handle and bring much lower prices on the market than the larger chunks. With the absence of fumes under the new method, miners can start loading coal immediately after the "shooting" and do not have to wait until the air clears. The mine level does not have to be vacated, as is the case when explosives are used.

With the new method a portable compressor stores air up to 15,000 pounds pressure in a long metal cartridge. The latter is inserted in a hole drilled in the face of the coal and a valve suddenly releases the air, which, in expanding, pushes out the coal in big chunks. The steel cartridges are specially designed and may be used over again. The entire operation is conducted directly at the coal face, and cartridges are filled in 90 seconds. Miners and equipment retreat to a distance of 100 or 150 feet during the explosion.—*A. E. B.*

Nickel-Cast-Iron Skillets

A new metal for home utensils is being introduced by the Chicago Hardware & Foundry Company, in its line of nickel-cast-iron frying pans. This nickel iron has

been used for years in industries where corrosion of equipment is a serious factor, but the skillet is its initial appearance in the home.

Originally developed for use in such industries as the paper and pulp production, packing houses, soap factories, and so on, this iron contains about 20 percent nickel to enable it to withstand the corrosive attack encountered in such service. This nickel also increases the toughness of cast iron to a marked degree, and changes its gray-black color to a shining silver.

Silvery Monel metal and stainless steel have already made the trip from industry into the home, but this is the first instance of a lustrous cast iron being offered for home service.

EMERY

MOST of the world's commercial emery comes from one place in the world, an island off the coast of Greece.

Oversold Terrors

WAR, if it should come to peoples already "withering away for fear," may surprise them by not being as completely infernal as they expect. Visions of wholesale raids by airplanes, wiping out entire cities with "a few pounds of secret poison gases," will not be realized, assert professional military men, irked at the facile prophecies of civilian "experts" in easy-chairs. Neither will the artificial spreading of disease epidemics wipe out whole populations, declare army medical men.

New chemical-warfare weapons have been investigated intensively since the close of hostilities in 1918, and a number of compounds of possible military value have been turned up. But none of them is any more powerful than the war-time phosgene and mustard gas, and most of them are not as effective.

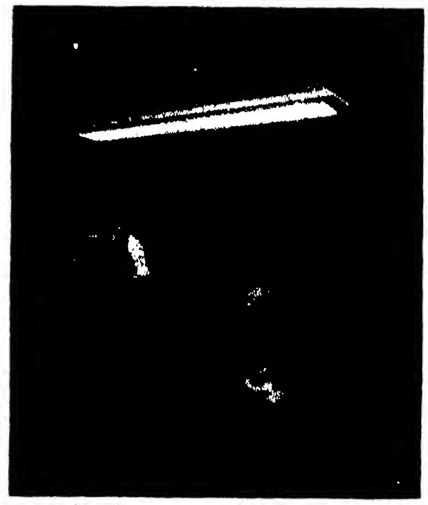
There may be mass airplane raids on cities, but they are too expensive in losses of both men and planes to be directed merely at areas of civilian houses. Their objectives will be industrial plants, warehouses, transportation terminals, and other concentrated targets of military significance. And modern anti-aircraft guns and counter-attacking combat planes would have a word of their own to say about even that.

It would be possible, either by airplanes or spies, to dump quantities of bacteria into city reservoirs; possible, though with vastly more difficulty, to infect city milk supplies. But to what end? Water can be filtered and boiled, milk pasteurized, populations protected by the measures of hygiene and preventive medicine which they should be using even in peace-time.

Popular fear of these things, in some cases bordering on hysteria, is probably due at least in part to the unprecedented rate at which the World War hatched horrors. No previous conflict ever brought such a combination as poison gas, aircraft bombing, tanks, super-long-range guns, and unrestricted submarine warfare. Imbued as most of us still are with the 19th-Century notion of the "inevitability of progress," we naturally expect the "next war" to begin where the last one left off and go even further. This uninformed terror of "what shall come upon the whole world" is quite conceivably a factor pushing us toward a new war, as we are all fatally fascinated by the very things we fear most. A sober, square look at the actual possibilities of present-day military technology, rather than a shuddering reading of the apocalypses of imaginative writers, might do much to allay hysteria and still leave us with a sufficient distaste for war.—*Science Service.*

New "White" Light Aids Production

AN industrial white light said to be restful on the eyes and to permit increased efficiency in high-bay lighting has been developed by the General Electric Vapor Lamp Company. The new lamp is not



Testing synthetic "daylight"

actually white. It combines light blue and yellow-green which, however, produce a white sensation to the observer. The lamp gives an intensity of 14,000 lumens at a current consumption of approximately one watt per 35 lumens.—*A. E. B.*

New Nitrocellulose Finishes

A METHOD for producing a nitrocellulose plastic coating on any type of material—wood, glass, metal, rubber, and so on—has recently been developed and gives promise of an important advancement in the technique of surface coating, says *Solvent News.* By means of the "Macoid" process, which is patented, pigmented coatings of nitrocellulose may be developed in a wide variety of decorative effects and it is reported that they possess great mechanical strength, plus resistance to wear, weathering, and chemical action.

The process is based on the application of a nitrocellulose plastic in the form of a heavy, viscous solution. Parts to be coated are dipped in the material under controlled conditions of humidity and temperature in the dipping room. Thickness of the coat, usually ranging from 0.005 to 0.020 of an inch, is controlled by the viscosity of the solution and the speed of the dipping operation.

Among the many applications which are said to lend themselves quite economically to the process are: automotive hardware, instrument boards, and fittings; aircraft fittings; and aircraft propellers.—*A. E. B.*

CURRENT BULLETIN BRIEFS

The Metallurgy of Oxy-acetylene Welding of Steel is an illustrated abstract of a paper read before the International Acetylene Association by J. H. Critchett. It tells briefly and clearly what happens during welding and some of the precautions that must be observed. *Write for Bulletin 1035A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

World Chemical Developments in 1934 is a Supplement to Trade Information Bulletin No. 823 and covers such subjects as dyes, heavy chemicals, paints and varnishes, chemical specialties, and so on. Request Trade Information Bulletin No. 824. *Superintendent of Documents, Government Printing Office, Washington, D. C.—5 cents (coin).*

On Health's Highway tells the story of research in cancer control and particularly the rôle which has been played by animals in the study of scientific medicine. Thoroughly illustrated. *The New York City Cancer Committee, 150 East 83rd Street, New York City.—50 cents postpaid.*

Bentonite Technology and Industrial Uses. Bentonite is a natural clay-like substance found in certain parts of the United States which has many applications in various industries. It has a great affinity for water, swelling to many times its original volume when saturated. It is widely and successfully used for stabilizing emulsions of many immiscible substances. A series of bulletins under the above title, bound in loose leaf form, $2.00 postpaid, which price includes, for one year, additional sheets which are issued frequently. *American Colloid Sales Division, Inc., 363 West Superior Street, Chicago, Illinois.*

Livable Homes Made with Phemaloid Compound Lumber tells the story of a new type of building material made of real wood, cross laminated and bound together with a synthetic resin. The resulting material is exceedingly strong and has many advantages for interior and exterior construction. *Write for Bulletin 1035C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

Concrete Improvements Around the Home is a well illustrated and attractive booklet of 46 pages showing exactly how to build all kinds of concrete objects for the home. Cisterns, lawn benches, curbs, posts, sidewalks, sundials, garden pools, and so on are described and illustrated. An excellent section of the book tells how to mix good concrete, and the steps are shown by photographs. *Portland Cement Association, 33 West Grand Avenue, Chicago, Illinois.—Gratis.*

Smithsonian Annual Report for 1933. A notable assemblage of reprints of scientific articles on gravitation, the galaxy, contents of space, high voltage, meteoric craters, and subjects in general of interest to scientific people. This is the latest volume.—*Government Printing Office, Washington, D. C.—70 cents.*

Color Helps, by Joseph Cummings Chase, gives the essential facts about colors, their selection, mixing, and application. Illustrated with several color plates. Of value to anyone who wants to use color for any purpose whatsoever. *S. A. Eisenman, 345 East 33rd Street, New York City.—50 cents.*

The Light Sealair Window is a circular illustrating and describing an aluminum window frame which is furnished as a complete unit and requires no difficult assembling. *Write for Bulletin 1035B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

Three Centuries of Chemical Industry in America, by Edward R. Weidlein and William A. Hamor, is a reprint of an article which originally appeared in *Chemical & Metallurgical Engineering*, tracing the history and development. *Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.—Gratis.*

An Introduction to Nebraska Archeology, by William Duncan Strong. A 316-page illustrated detailed paper-covered book on American Great Plains archeology, Nebraska in particular. Written by an anthropologist at the Bureau of American Ethnology at Washington. *Smithsonian Institution, Washington, D. C.—$1.50.*

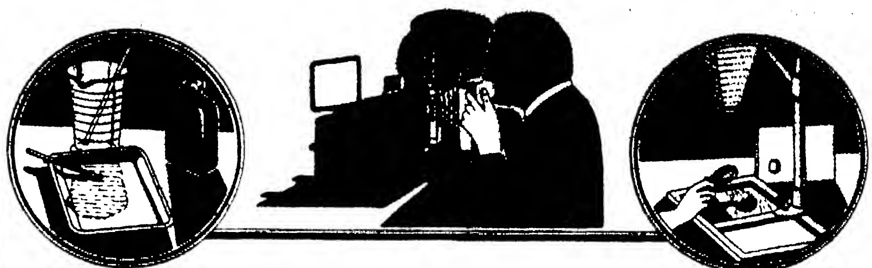
The Moly Matrix is a bulletin describing the various uses of Molybdenum as a constituent of alloys. Uses for Molybdenum are discussed at some length and the text is accompanied by pertinent illustrations. *Write for Bulletin 1035D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

Studio Speech Input Equipment to Meet Modern Broadcasting Needs gives technical data on a new line of such equipment. Thoroughly illustrated with photographs and line drawings. *Western Electric Company, 195 Broadway, New York City.—Gratis.*

A Folsom Complex is a preliminary report on investigations at the Lindenmaier site in northern Colorado, and will be of interest to those who are trying to keep track of Folsom man in early America. *Smithsonian Institution, Washington, D. C. —30 cents.*

The A. B. C. of Better Iron and Steel is a beautifully illustrated pamphlet which graphically tells the story of the improvement possible in iron and steel when alloyed with Molybdenum. This is a "high spot" story of progress in one branch of metallurgy. *Write for Bulletin 1035E to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

Watch for the November
NAVY NUMBER
SCIENTIFIC AMERICAN
(Announcement on page 170)

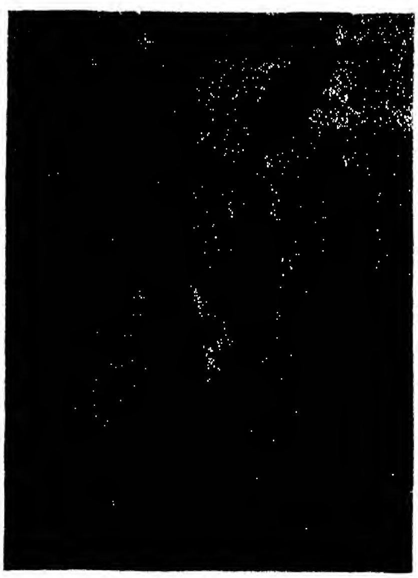


CAMERA ANGLES

Conducted by JACOB DESCHIN

"Angle" Photography

WHEN a man operates a camera from an unconventional point of view he is practicing what is known as "angle" photography. Strictly speaking, an angle photograph is any shot other than a straight-on view, but in modern photographic parlance the term "angle" takes on a double meaning—the interpretive as well as the geometric. The mental angle, that is, the photographer's notion of the point of view best suited to tell the photographic story, determines the purely mechanical feature of how the camera is to be pointed at the subject. "Slant" photography might be a more appropriate term, or, perhaps, "slant angle" photography.



"Brother, can you spare a dime?"

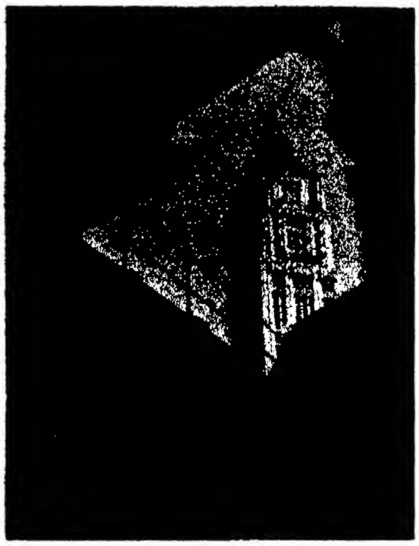
By means of angle photography, cameras have often been made to transform the commonplace into the unusual by showing the familiar in an unfamiliar way. Thus, the picture of a panhandler in the act of plying his trade would be just another picture if taken from street level, but take the camera up to the platform of the elevated railway some distance above the street and shoot down and you have something else again. A picture of a woman sitting on the beach might or might not be worth the candle, but get on your back and shoot at the woman's head with the sky for background and see what you get.

While architectural subjects are peculiarly suited to angle photography, street scenes, portraits, and action pictures are some other fields in which the unusual approach will yield striking and unusual pictures. Every camera user alert to picture possibilities has had the delightful experience of accidentally viewing a subject from an unfamiliar angle and "seeing" a picture he never thought existed, whether the subject be a building, a telegraph pole, or just a group of boys playing marbles on the sidewalk.

Many subjects may be shot from street level with the camera pointed upward, but scenes involving people generally call for down shots, which means the photographer has to climb. Handy places are the stairways of the elevated railway or the "stoops" in front of old-fashioned brownstone houses. If the "shooting" is done at home, a ladder may become a very useful photographic accessory. When no elevation is at hand, an angle shot from above may still be made by lifting the camera above one's head, if it is of the reflex type, and looking up at the ground glass while tilting the camera down. If the photographer can afford the price, he will find a telephoto lens very desirable in this type of work. Occasions for its use will come up every day and if he really becomes interested in angle work he will want to carry a telephoto around with him all the time.

Appreciation of design and a sense of composition are essential to success in this work. It is not enough merely to tilt the camera up or down in order to view the subject at an angle. Study the subject carefully and observe it from this point of view and that until the composition looks just right. If, after much experimentation, the first impression proves to have been just a fancy, leave the subject alone. A photograph, after all, mirrors only what the lens faces, nothing more or less. A point to look out for in photographing buildings at an angle is not to get too far away. In shooting a skyscraper at an angle you must reconcile yourself to the fact that you can't get the upper part of the building and the bottom as well and still have a picture worth the taking. If you stand far enough away you will, to be sure, get the bottom as well as the top, but the whole building will look as if it's toppling over. A little study will bring the solution as to just where to stand. Watch for a variety of line, alternating straight lines with curves. Wherever feasible, try to get clouds in the picture, and in general, particularly in the case of down shots, strive for interesting lightings and shadow patterns.

Angle photography should offer the person spending his vacation in a city innumerable opportunities for pictures he cannot buy from postcard vendors. His friends back home will be grateful for the



An unusual angle shot through an opening in the Elevated structure

"something different" quality in the pictures he sends them and he himself will have a collection of pictures that will forever after recall impressions that might possibly be lost if not recorded on the spot by means of a camera pointed at an angle.

New Low-Priced Exposure Meter

SOMETHING of a mild sensation in photographic circles has attended the recent introduction of a precision exposure meter selling for less than two dollars. Called the Leudi, it is of the visual or "extinction" type, but it differs from other meters in its class by the fact that it is not held close to the eye but about 10 inches away. It is extremely small in size—1½ by ½ by ¾"—and is very light in weight. While its insignificant appearance would seem to militate against it, comparative tests with the highest-priced instruments now on the market have shown it to be remarkably efficient, particularly under artificial light conditions. Its inconspicuousness, dependability, simplicity of operation and extreme portability, occupying a space no bigger than that required for a few coins, have already been recognized by many who have never owned a meter because they could not afford the price.

When the instrument is pointed at the subject to be photographed, a series of numbers from 1 to 8 may be seen. The lowest number that can be seen without straining the eye is the key for calculating the correct exposure, which is done by consulting a scale on the outside of the meter, the guides being five differentiated squares indicating light conditions from the brightest outdoor scenes to interiors lighted by artificial light. After the least visible number is placed on one of these squares the exposure time for any opening is read off automatically. The meter may be used for both still and motion picture photography.

Super-X Film

FIFTY percent faster than supersensitive, Eastman Super-X film for 35-millimeter film users is the latest contribution of the film makers to the cause of more efficient "candid" camera work and other types of photography under adverse light conditions. The manufacturers call it "the film that makes your fast lens twice as fast." This statement should prove heartening to owners of $f/4.5$ and $f/3.5$ lenses, who may have had poor success when attempting indoor, night, and theater shots with the fastest emulsions hitherto obtainable.

Incidentally, the advantage and money-saving involved in the use of bulk film should be given greater consideration by advanced amateurs who do their own processing. Not only is the price of film material reduced by about two thirds, but the film may be cut to any length desired, so that if the worker knows in advance that he will take only about a dozen shots, he may cut his film accordingly and thus obviate the delay and annoyance of having to wait until the entire roll of three dozen is exposed before he develops the roll. This feature may often prove of incalculable advantage, as when prints are needed in a hurry, or when exposures are made for testing purposes. The saving involved is a very considerable factor, since at the low price the worker can afford to take many shots of a single much-desired subject without ever considering the cost. Well-known users of miniature cameras, such as William Mortensen and William Rittase, have said that when they are working on some particular subject which they want to be sure to get they may expose as many as a hundred or more shots before they leave it.

Film Reversal

SIXTEEN-MILLIMETER motion picture film is the only film at present on the market that may be chemically reversed; that is, in which the developed result of the exposed film is a positive instead of a negative, the procedure being direct. However, any film may be "reversed" by developing it in the usual way and then printing on positive film, the latter being used for projection or as a transparency. The professional 35-mm motion picture film is "reversed" for projection in this manner. As to projection, machines are at present limited to 35 and 16-mm film sizes, in addition to the lantern slide projector which takes glass slides 2¼ by 3¼ inches. Sizes other than these they may be used as transparencies.

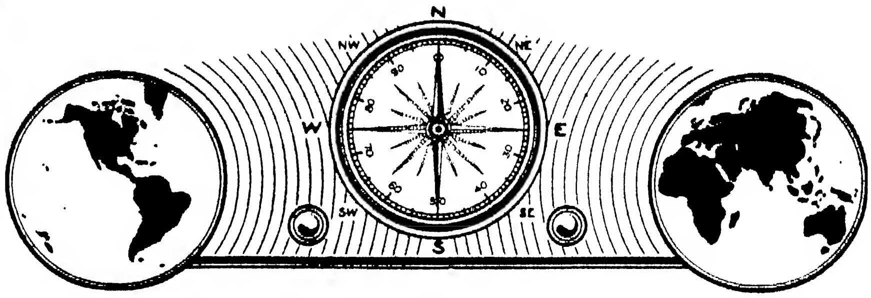
The formula for developing reversible film is D-16, which follows:

Water	10 gallons
Elon	180 grains
Sodium Sulphite	3 pounds, 5 ounces
Hydroquinone	8 ounces
Sodium Carbonate	1 pound, 9 ounces
Potassium Bromide	1 ounce, 63 grains
Citric Acid	400 grains
Potassium Metabisulphite	2 ounces

Develop 7 to 15 minutes at 65 degrees, Fahrenheit.

Photoflood Reflector

A NEW 10-inch Photoflood reflector and stand is made of heavy gage aluminum, highly polished on the outside while the inside is frosted to furnish a soft diffused light. It holds two lamps. Attached to a collapsible stand by a swivel joint, it can be extended to 7½ feet and folded down to 26 inches. When opened, the legs of the stand clamp automatically.



WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN*

THE 1936 ALL-WAVE RECEIVERS

THE new Fall lines of all-wave receivers are in the hands of the dealers. The formal introduction of these sets to the public takes place in New York at the Electrical and Radio Exposition, Grand Central Palace, September 18th to 28th, inclusive.

Many new features have been included in all-wave receivers for the coming year. Practically every manufacturer in the field has created a complete line of sets employing the new metal tubes. Some producers will continue with a line of glass tube receivers as a complement. A few manufacturers have introduced sets in which either the glass- or metal-type tubes may be used, at the option of the purchaser.

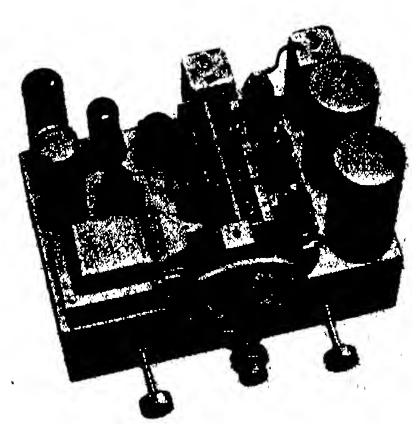
Manufacturers are placing great emphasis on precision and simplicity of design in their advertising. The receivers back up the claims, too. RCA Victor continues pushing the "Magic Brain" unit, to which, incidentally, has been added a "Magic Eye." This "eye" is a miniature cathode-ray tube with a fluorescent screen flush with the front panel. On this screen one may "view the signal" as it passes through the receiver, and by the width of the light band on the screen, determine immediately if the receiver is correctly tuned. The larger RCA Victor sets also have dynamic loud speakers with dual voice coils, one for reproducing bass notes and the other for reproducing treble.

General Electric receivers blossom out with the "Sentry Box" unit, a compact metal case containing all circuits that are manually tuned. The delicate, sensitive circuits are thereby isolated from the remainder of the receiver and, in consequence, are less subject to disturbances or changes in constants. The console receivers have a new type of dial, similar in some respects to a type of scale recently introduced in Germany and Austria, but with improvements. The G. E. dial is in the form of a drum. The pointer travels laterally across the surface of the drum on which the frequency divisions are marked, while the drum itself revolves with a change in the setting of the band-selector switch, thus bringing in line with the pointer another frequency scale. With this arrangement, only one scale is visible at a time, resulting in less confusion.

United American Bosch are playing up their "CentrOmatic" units. All the delicately adjusted, manually tuned equipment is in a single case located in the heart of the receiver. This unit is interesting as contrasted to other systems in that it contains no wiring. Each coil is locked to its terminal posts and switch contacts. Wiring and soldering are thus dispensed with. Theoretically, the absence of wire leads and soldered connections in this unit should boost sensitivity materially.

The emphasis on precision and simplicity of design is of paramount importance. Without real precision adjustment of circuits, a highly sensitive and selective all-wave receiver is out of the question. If it is to be highly sensitive to weak signals, and capable of selecting one signal from another no more than a hair's breadth apart on the dial, extreme precision in manufacture is required. In order to obtain high degrees of precision, simplicity of design is necessary.

In connection with these points, it is worth noting that a large number of the 1936 all-wave receivers include many components impregnated with compounds to keep out moisture, for even a comparatively low degree of humidity can throw off the



Courtesy International Radio Corp.

Either metal or glass tubes may be used in this new receiver chassis

circuit adjustments in a radio receiver if the moisture is permitted to enter the insulation of coils and condensers.

Heat is another disturbing influence in cases where precision adjustments must be maintained, for heat expands metals, and if the copper wire in short-wave coils is permitted to expand and contract, and the metal plates of small trimming and padding condensers are permitted to alter their positions by the same cause, the receiver cannot be kept in tune with signals; in the modern, highly selective receiver, this results in a terrific drop in sensitivity.

Heat in a radio receiver is produced by

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

the tubes, the power transformer, the field coil of the dynamic loud speaker, and by power resistors. In many of the 1936 all-wave receivers the delicate components, such as coils, condensers and resistors of high value, are protected from heat by mounting them in protective cases, or by placing them well away from heat-producing sources. In either case these components are maintained at a fairly constant temperature and this assures constant circuit adjustments.

Amateur "Phone" Transmitters

AMERICAN amateurs are permitted to operate radiophone transmitters in the following frequency bands: 1800 to 2000 kc.; 3900 to 4000 kc.; 14,150 to 14,250 kc.; 28,000 to 28,500 kc.; and 56,000 to 60,000 kc. The last two frequency bands are not covered by the average all-wave receiver, a special set being required to listen to them.

Only amateurs holding Class A licenses are permitted to use the 14,150 to 14,250-kc. band. This is the famous "20-meter band" and is the most interesting of the lot. It is distinctly a long-distance band and is practically valueless as a medium for short-distance transmissions. [See page 232, May 1935, Scientific American, for an explanation of this phenomenon.—*Editor.*]

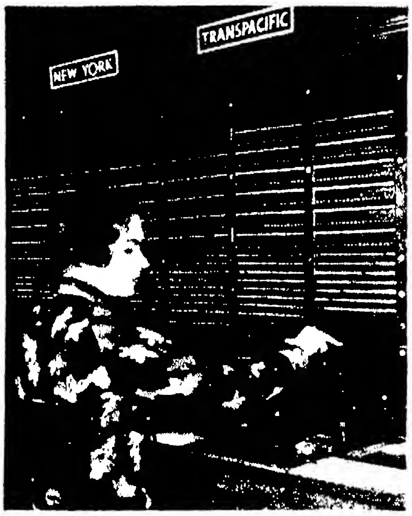
The 20-meter band goes dead shortly after sundown, the exact time depending upon the season and upon atmospheric conditions. An amateur using this band may be able to carry on long-distance communication as late as ten or eleven o'clock in the evening. When the band dies, he switches the frequency of his transmitter to 4000 kc (around 80 meters) or 2000 kc (around 160 meters). These are both excellent "night-time frequencies" but are not quite so satisfactory for long-distance communication. Moreover, since these bands are not restricted, there is more crowding of stations than is found in the 20-meter band.

Though the American amateur is restricted to the frequencies between 14,150 and 14,250 in the 20-meter band, foreign amateurs may operate outside of these limits. Most of the foreign amateurs operate just beyond the limits of the high-frequency end of the American band; that is, slightly above 14,250 kc. Since this frequency area is free from local interference, it is not at all difficult for the American listener to hear amateur phone stations in Canada, England, Holland, Belgium, Africa, South America, and other distant countries. However, many of the Canadian, Central American, and Mexican amateur stations operate within the frequency limits of the American amateur band.

In any event, when listening in on the 20-meter band, do not fail to search a bit above 14,250 kc. Early Saturday or Sunday morning is the best time for picking up the Europeans. Very few are heard after 9 A.M.

Not Chinese . . .

SHOULD you pick up the voice of an individual presumably talking in a tinny-sounding Chinese, do not make the mistake of logging "China" on your list of stations received; it is nothing more than scrambled



"Scrambled" speech is used in commercial radio channels to prevent eavesdropping. Transpacific calls go through this switchboard

or inverted speech being transmitted over one of the many world commercial radiophone channels.

Scrambling is resorted to so that you may not be a willing or unwilling eavesdropper. The voice of the person on the phone is inverted prior to transmission by radio, and reassembled in its proper order at the radio receiver before being placed on the telephone land lines.

Commercial "Code" Stations

COMMERCIAL radio telegraph transmitters do not employ steady carrier waves, as do radio broadcast transmitters. The wave is transmitted only when the telegraph key is closed in the formation of code characters.

Some code stations modulate the transmitted wave with an audible frequency, but the majority of stations use a pure wave, with no modulation whatsoever. The modulated code signals are heard in an all-wave receiver just as readily as a broadcast program. The unmodulated signals cannot be heard, except as interrupted clicks or hissing sounds when the signals are of sufficient intensity. Therefore, the user of an all-wave receiver must not infer that these sounds are created by local electrical appliances. Electrical interference of this last mentioned nature cannot be tuned out; consequently, if the noises you hear may be eliminated by a slight movement of the dial pointer, you may rest assured it is a code station.

If, on the other hand, the noise cannot be tuned out, and, yet, from the sound and character of the signal, you are moderately sure it is a commercial radio telegraph station, the interference is being created by a code station operating at the same frequency as the intermediate frequency of the amplifier in your superheterodyne receiver; in other words, the signal is from a long-wave code station, not a short-wave station.

This condition may be cured by installing a "wave-trap" in the antenna lead to the receiver. The trap is tuned to the same frequency as the amplifier in the receiver. This prevents the long-wave code signal from breaking through.

Books SELECTED BY THE EDITORS

WALTER FRANKLIN PRINCE —A Memorial

READERS of SCIENTIFIC AMERICAN are familiar with some of the works of the late Dr. Walter Franklin Prince, who contributed largely to these pages during the last ten years or so of his life. On matters pertaining to psychic phenomena, telepathy, and allied subjects, Dr. Prince was considered as the final authority, the last court of appeal. His vast knowledge of these obscure corners, to which few are willing to grant the title of science, was matched only by his keen analytical sense and his open-minded attitude during the investigation of any disputed subject. As Research Officer of the Boston Society for Psychic Research, he rendered services in the search for truth that have never been equalled before, and probably never again will be equalled by any one worker.

After the death of Dr. Prince, the Boston Society set about to gather material for a memorial volume, and the present book is the result. In no sense of the word is it a eulogy. Rather, it presents a clear-cut picture of a man among men—a sincere worker in a field where trickery and deception runs rampant, yet in which he pressed forward unceasingly, taking the bitter with the sweet and searching ever for the elusive truth. To the student of psychic matters or to the layman who is casually interested in the subject, the book will give a well-balanced conception of the value of Dr. Prince's work. Also, the bibliographies published in it will prove to be a valuable guide to reference works, many of which would be difficult to locate otherwise.—$2.15 postpaid.—*A. P. P.*

A HISTORY OF SCIENCE, TECHNOLOGY AND PHILOSOPHY IN THE 16TH AND 17TH CENTURIES

By A. Wolf, Professor and Head of Department of History of Science, Univ. of London

IN the 16th and 17th Centuries the foundations of the modern Age of Science were laid—Copernicus, Galilei, Tycho Brahe, Kepler, Newton, and other great lights—and no one can hope to understand our present science intelligently without the knowledge of its background conferred by the history of science. This monumental, 675-page illustrated history covers the most important period. It traces the growth of astronomy, mathematics, physics, meteorology, geology, biology, medicine, and the various technologies, and is written in a clear, readable style. It is such a book as would appeal, say, to a manufacturer or a well-read business man rather than a greasy closet student. An educated man is one who can see things as a whole; others see only the particular. Nothing gives this perspective like history and, in science, the history of science.—$7.25 postpaid.—*A. G. I.*

WAR AND WAGES

By Maj. Robert E. Adams, U.S.M.C., retired

THE need for an adequate national defense to prevent war has been shown by Major Adams in this outstanding book. It is a history of the wars in which this country has engaged, showing how these wars were effected by the policies of other countries, and how they could have been prevented if only we had possessed adequate means of national defense. It is such an essentially honest book that it is bound to stir vehement criticism among those "disarmament by example" fanatics who won't relish the idea of being blamed, even indirectly, for the excessive losses in men and money attributed to the unwillingness of their fellows to permit the development of an adequate national defense system prior to our wars. On their shoulders, however, lies the blame, as this volume demonstrates. We recommend it to those who, in this day of world peril, wish to face facts squarely, who are open-minded and willing to learn; and to those who are already in the thick of the fight for national defense.—$3.20 postpaid.—*F. D. M.*

SALES AND ADVERTISING (In Two Volumes.)

By Chester A. Gauss, E.E., M.E., and Lucius I. Wightman, E.E., M.E.
Revised by Harry A. Bates

THE twin problems of sales and advertising are so closely linked with almost every business and industry of the present day, and the problems involved are often so involved in solution that there is a wide-spread need for a comprehensive guide. The two volumes of the present work will go far to fill this need, and can be read with profit by anyone connected with business or industry in any capacity from clerical work to that of an active executive.

The book is described by the publisher as: "A practical treatise covering the psychology of selling and advertising, analysis of sales, advertising and its relation to selling, copywriting, typography, mechanics of advertising, advertising department systems, and the control of advertising and sales ex-

pense." Although the two volumes comprise 555 pages of text matter, including many illustrations, the authors appear to have been hard put at times to cover adequately the many involved phases of their subject. As a result, some of the subjects are "high-spotted," but still retain enough meat to satisfy anyone who wants only a background of knowledge, rather than a comprehensive education in some one particular part of the business of sales and advertising. The text is presented in an easy-to-read manner that makes for rapid assimilation of the content.—$6.20 postpaid for both volumes.—*A. P. P.*

ANCIENT EGYPTIAN MATERIALS AND INDUSTRIES

By A. Lucas, O.B.E., F.I.C., F.S.A.

READERS who incline to think the ancients were slouches when it came to technical handiwork, such as stone carving, wood working, metal working, and manufactures of things in general, will be surprised to discover from this extensive book by a former chemist of the Egyptian Department of Antiquities, what kind of workmanship they really did perform in ancient Egypt. In a lot of ways they appear to have been as skilled as we are in 1935. The data in this book are not based on mentions in classical literature, an unreliable source at best, but on the author's first-hand inspection of tangible evidences in Egypt and on actual chemical analyses of things like alloys and glass. The book is unillustrated and its style not very "exciting," but it is good sound stuff.—$6.25 postpaid.—*A. G. I.*

ALONG THE HILL

By Carroll Lane Fenton

THE publisher's own blurb accurately describes this little book, suitable for kids young or older. "This handy-sized book, for use in the field, tells in clear drawings and text about the rocks, the soils, sands, shells, fossils and other evidences of the ever changing, ever fascinating story written indelibly in the hills around us. It is for beginning adults as well as for children. It will be found adapted to use by schools, camps, and nature study groups at all age levels." —$1.40 postpaid.—*A. G. I.*

HOW TO RIDE YOUR HOBBY

By A. Frederick Collins

THERE is probably no important hobby about which this author has not written, either in book or magazine article form. As we have remarked before in these columns, the author's admirable gift for prolific writing is frequently marred by obvious errors that somehow or other manage to creep in, but in this type of material such errors may easily be discounted. In any event, Mr. Collins has, in this book, made an attempt to compress into 298 pages, including a good index, a terse yet readable guide to the intelligent pursuit of a wide variety of hobbies. The wide range of subjects includes: collecting hobbies, musical hobbies, model making, photography, entertainment and amusement hobbies, the fine and manual arts . . . and so, "far into the night." If you ride a hobby or are looking for something with which to occupy your spare time, here is the book for you.—$2.15 postpaid.—*A. P. P.*

THE CATHODE-RAY TUBE AT WORK

By John F. Rider

ALTHOUGH the cathode-ray tube has long been familiar to laboratory technicians, it has only very recently been brought within the ken of the field worker. Today this electronic device is incorporated in oscillographs, which have a world of important applications. This book explains not only the theory underlying the functioning of the tube, but its manifold applications, especially to the different phases of the radio industry. The first chapters of the book deal with the theory of the cathode-ray oscillograph and clear explanations are given of the operation of the several types of oscillographs that are on the market today. Easily understood diagrams show how the different patterns are developed on the screen of the cathode-ray tube, and oscillograms are given which show exactly how these patterns appear. The rest of the book is devoted to the practical applications of the cathode-ray oscillograph, this part of the book being thoroughly illustrated with excellently reproduced oscillograms made from unretouched photographs taken in the author's laboratory.

There is no doubt that the cathode-ray oscillograph will be used more and more widely as time goes on, not only in industrial, but in educational fields. It is a new and important tool and because of this, "The Cathode-ray Tube at Work" fills a real need and should prove to be an asset to the man who is working with or can apply this device in any field whatsoever. Only by understanding the functioning of every part of the oscillograph can it be made to operate properly and efficiently and the present book provides the information that will give this needed understanding.—$2.65 postpaid.—*A. P. P.*

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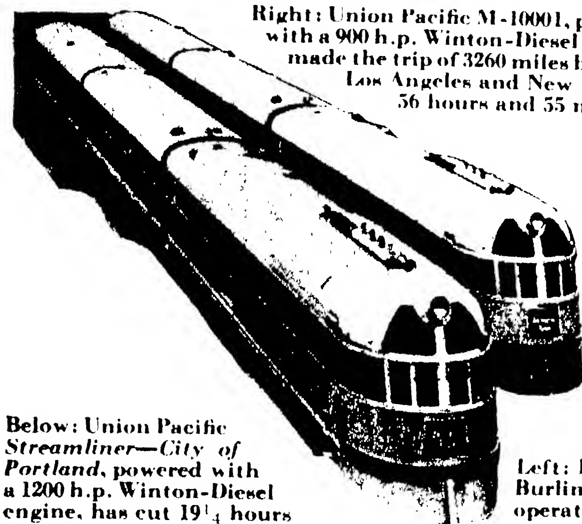
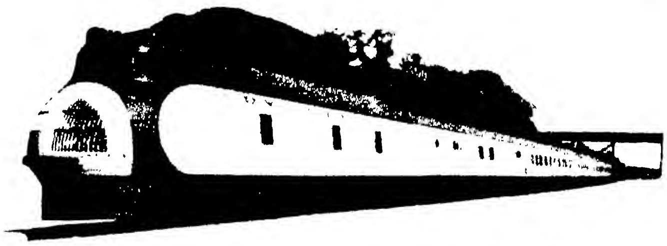
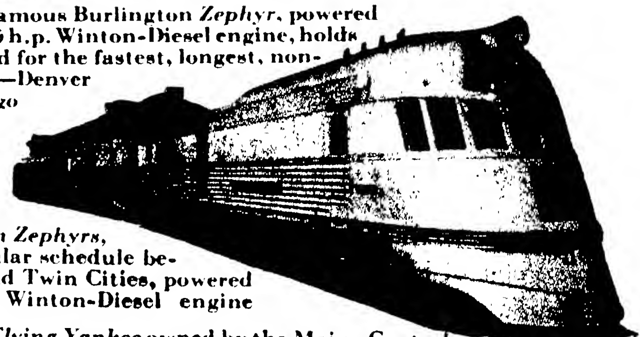
WINTON-DIESEL ENGINES *Electrify* THE RAILROAD WORLD



Right: Union Pacific M-10001, powered with a 900 h.p. Winton-Diesel engine, made the trip of 3260 miles between Los Angeles and New York in 56 hours and 55 minutes



Below: Famous Burlington *Zephyr*, powered with a 600 h.p. Winton-Diesel engine, holds the record for the fastest, longest, non-stop run—Denver to Chicago

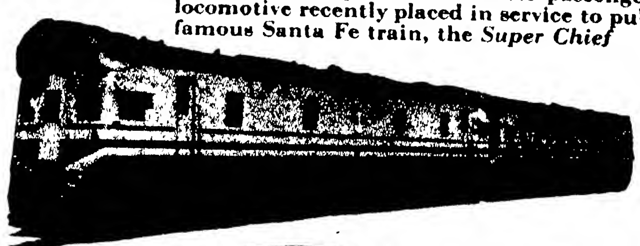


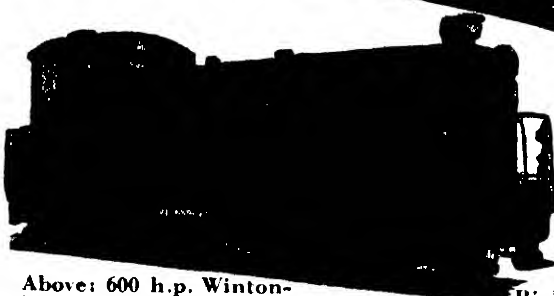
Below: Union Pacific *Streamliner—City of Portland*, powered with a 1200 h.p. Winton-Diesel engine, has cut 19¼ hours from the running time between Chicago and Portland

Left: Each of the Burlington's *Twin Zephyrs*, operating on regular schedule between Chicago and Twin Cities, powered with a 600 h.p. Winton-Diesel engine

Below: *Flying Yankee* owned by the Maine Central and Boston and Maine Railroads, first high-speed, streamlined train placed in regular service in the East, powered with a 600 h.p. Winton-Diesel engine

Below: 3600 h.p. Winton-Diesel passenger locomotive recently placed in service to pull famous Santa Fe train, the *Super Chief*





Above: 600 h.p. Winton-Diesel switching locomotive in D. L. & W Railroad service

Right: 1200 h.p. Winton-Diesel engine . . . sixteen cylinder, V-type

Above: 1800 h.p. Winton-Diesel road locomotive operated by The Baltimore and Ohio Railroad

WINTON ENGINE CORPORATION

SCIENTIFIC AMERICAN

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

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COVER

THE illustration on our front cover this month, taken during practice maneuvers, was supplied through the courtesy of the United States Navy. All photographs of naval vessels, equipment, planes, and so on, used in connection with articles in this issue are, unless otherwise credited, United States Navy, Official.

The SCIENTIFIC AMERICAN DIGEST

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Books SELECTED BY THE EDITORS

THE SOLAR SYSTEM AND ITS ORIGIN

By Henry Norris Russell, Professor of Astronomy, Princeton University

"IN clear, informal style, Dr. Russell sums up the present state of knowledge and theory concerning the solar system. He tells first of the dynamical properties of the system—its tremendous isolation in space, the probable age of the planets, and of how, probably about two billion years ago, the earth began an independent existence. He describes the comets and their strange tails—comets which are probably steadily wasting away, though Halley's Comet has been seen to grow 27 successive tails and shows no signs of exhaustion.

"He then takes up the physical and chemical properties of the system, and describes important work done here and abroad during the past few years, which, despite its general interest, is not yet widely known. The temperatures and atmospheres of the planets are next discussed with incidental bearing on the possibility of life upon them. Finally, he considers the various theories of the origin of the solar system the theories of Chamberlin and Moulton, of Jeans and Jeffreys."

This is the publisher's blurb, from the jacket of the book, and it accurately describes it. The many SCIENTIFIC AMERICAN readers who tell us by letter that they "can never get enough of Russell" may now slip in some extra Russell by reading it.—$2.15 postpaid. —*A. G. I.*

PARADE OF THE ANIMAL KINGDOM

By Robert Hegner, Ph. D., Assisted by Jane Z. Hegner

A TOTAL of 743 clear illustrations would by themselves make this book what it purports to be, but in addition, 664 pages of carefully compiled text, descriptive of animals, birds, and reptiles, make of it an excellent reference work. This is an unusual natural history of animals written for all those who wish to know something about the modes of life and activities of the animals they see or read about. The authors have chosen representatives of each large group of the animal kingdom arranged in the order of their complexity from amoeba to man. We recommend it to all who are interested in animals to the slightest degree because the authors have taken pains to tell what most people want to know about animals where they live, how they protect themselves, where and how they obtain their food, how they reproduce themselves, how they pass the winters. This is a splendidly made book 7 by 10¼ inches and weighing five pounds.—$5.50 postpaid.—*F. D. M.*

THE LEICA MANUAL

By Willard D. Morgan and Henry M. Lester

ALTHOUGH this beautifully produced book is directed mostly to users of Leica cameras, it is full of information that will be of great benefit to any photographer. In fact, only one or two chapters are so specifically concerned with the Leica as to hold little interest to users of other miniature cameras. Some of the subjects covered include the making of positives, stereoscopic photography, panoramas, miniature monsters, photomicrography, infra-red photography, astronomical and candid photography, photo-murals, and so on. This is a beautifully produced book of 502 pages, thoroughly illustrated with excellent photographs, and printed on fine coated stock.—$4.00 postpaid —*A. P. P.*

THE STRUCTURE OF CRYSTALS

By Ralph W. G. Wyckoff

THIS is a supplement to Part II of the second edition of the author's well-known book on the X-ray diffraction method for the determination of the structure of matter. It is a technical book that is recommended to those who are already on familiar terms with the original book.—$6.20 postpaid.—*A. G. I.*

ADVERTISING LAYOUT AND TYPOGRAPHY

By Eugene de Lopatecki

FACED with the necessity of preparing advertising copy, suggesting ideas for advertising campaigns, or presenting in an understandable manner a layout for any kind of printed matter, the average business man is likely to throw up his hands and cry quits. Yet the ability to meet such a situation is frequently desirable in many businesses, and the man who is equipped to do so will often find himself in an advantageous position. This book literally takes the reader by the hand and leads him, step by step, through the whole art, making every step as simple and easy as possible. It was written by an experienced art director who himself makes use of the exact methods which he so lucidly explains, and is illustrated with numerous drawings. Each chapter is set in a different font of type, so that the reader is able to judge for himself the effectiveness of the various styles.—$3.15 postpaid.—*A. P. P.*

THE NEW SCIENCE AND THE OLD RELIGION

By Thornwell Jacobs, Litt. D., LL. D.

THE president of Oglethorpe University, of Atlanta, presents in this work a 517-page, illustrated survey of cosmology, evolution, human origins and an orientation regarding the meaning and nature of life, in an attempt to find a formula that will make it possible for the reader "to keep his faith without stultifying his judgment." The author regrets the fact that, as he says, "the majority of our religious leaders are, most unhappily, arrayed in fierce opposition to the evolutionary and revolutionary teachings of modern science," a fact which "is proving fatal to the churches, driving from their doors those whom they can least afford to lose." The book leans heavily in the direction of religion but not fundamentalism, and should be acceptable to those who believe there is no opposition between religion and science, and who cherish religion.—$3.95 postpaid.—*A. G. I.*

SAHARA, THE GREAT DESERT

By E. F. Gautier

THIS is a scientific treatise covering every aspect of the Sahara its climate, desert life, geology, history, and its individual regions in fascinating style of language. The author is professor in the University of Algiers and he knows his Sahara. The book is illustrated and has a folding map of the desert. The mystery of the Sahara exists only for those who have *not* read this book.—$3.90 postpaid.—*A. G. I.*

ACROSS THE EDITOR'S DESK

THE year 1935 rounds out 90 years of service for the United States Naval Academy, at Annapolis, and for SCIENTIFIC AMERICAN—the birthday of the one having fallen in September and of the other in August. Both have reflected the genius of the American people, the pioneering, progressive, and peaceful spirit of the founders of the country; and, in their seemingly separate and distinct rôles, have often found their interests intertwined, identical. Both have always stood firmly for peace—for peace with honor; have striven for adequate means to meet any menace from within or without; and have fought all manner of ideologies that would undermine the very foundations of our scheme of government and substitute, instead, a system, or systems, tainted with foreign beliefs or hatreds. When radical thought has reared its ugly Gorgon's head, staunch American ideals have been maintained in the United States Naval Academy (in which our Navy finds constant renascence) and in SCIENTIFIC AMERICAN.

It is primarily because of this linkage and of the old naval tradition of this journal that this November, 1935, issue is devoted largely to a study of navies, our own in particular. (Odd how little the average American citizen knows about his Navy, and how little he cares! Odd, and tragic, too, if the United States should be attacked!) By virtue of our peculiar situation, as regards the world of science and industry—in both of which the Navy stands as preceptor and collaborator—it is the aim of this issue to present a many-sided picture of this vital arm of the National Defense in such a way as to show that it is not an abstract idea but, rather, a defender of the soil. From the wide variety of articles here collected, it is hoped that those inlanders who have never seen the oceans that surround us and to whom a battleship is but a pretty and expensive toy may gain a new understanding of the Navy's worth to them.

Japan, having built her navy nearest to Treaty strength—of all signatory nations—has abrogated all naval treaties. Britain later discarded them. First, however, she signed with Germany, without consultation with other powers, a treaty giving Germany the right to build up to 35 percent of Britain's strength. From this there follows a concatenation that seems destined to lead to disaster. France, angered at Britain's concession to Germany and, too, fearing her old enemy, determines to build a stronger navy. To counter France, Italy, already on the verge of an African war, will build a more powerful navy—is already building two 35,000-ton battleships! Soviet Russia, finding Germany again a menace to her security in the Baltic, embarks upon a larger building program on her western shores. She is able thus to pay less attention than formerly to Japan, with whom she has always been at loggerheads, in the east. The increasing navies of Europe bring home to Britain the hard fact that she must hold the bulk of her navy near home.

The sum of all this, so far as the United States is concerned, is that two important checks—Britain and Soviet Russia—on the imperialism of the Japanese militarists in Asia have been greatly weakened. This leaves for the United States a very touchy situation, the outcome of which is hard to predict. Delicate handling is indicated. But unless our diplomats are careful, all of our conciliation will be construed as weakness—as it has been often in the past. Our rôle must be one of friendliness but rigid firmness. Other nations do not understand our sophomoric idealism, and so long as we are governed in international affairs by the acts of misguided zealots, foreign peoples will continue to tease our complacency while continuing to do things their own way—witness the disastrous effects of our "disarmament by example."

This country has declared itself for a Treaty Navy. Not by the wildest flight of fancy does this mean a naval building competition: it simply means obtaining for ourselves the strength agreed upon by the naval powers, in solemn conference assembled, long after these others have attained Treaty strength—or most of it.

Let us, then, look upon our Navy in a new light and try to understand its mission to preserve peace and to command the respect of the world for our peaceful policies. We are not an aggressor nation, but we do have huge interests throughout the world; our Navy is our main assurance that these will not be burglarized.

COMING

- **"In Quest of the Perfect War Gas," by Captain Alden H. Waitt, U. S. Army**
- **Dr. Charles Bache, on Some Prehistoric Burials**
- **"Clues for the Color Blind," by Dr. Clennie Bailey**
- **Developments in the Glass Industry, by Philip H. Smith**
- **S. F. Aaron, on Misinterpreted Animal Observations**
- **"The Mists of Madness," by Prof. George H. Estabrooks**

IN dedicating this issue to the Navy, we wish to express our appreciation for the splendid co-operation of the following who have helped make it a success: Secretary of the Navy Claude A. Swanson; Assistant Secretary of the Navy Henry L. Roosevelt; Admiral W. H. Standley; Captain W. D. Puleston, U.S.N. (our contributing editor); Captain Jonas H. Ingram, U.S.N.; Captain P. N. L. Bellinger, U.S.N.; Lieutenant W. B. Ammon, U.S.N.; and Dr. Oscar Parkes, London.

Orson D. Munn
Editor and Publisher

The U. S. Naval Academy

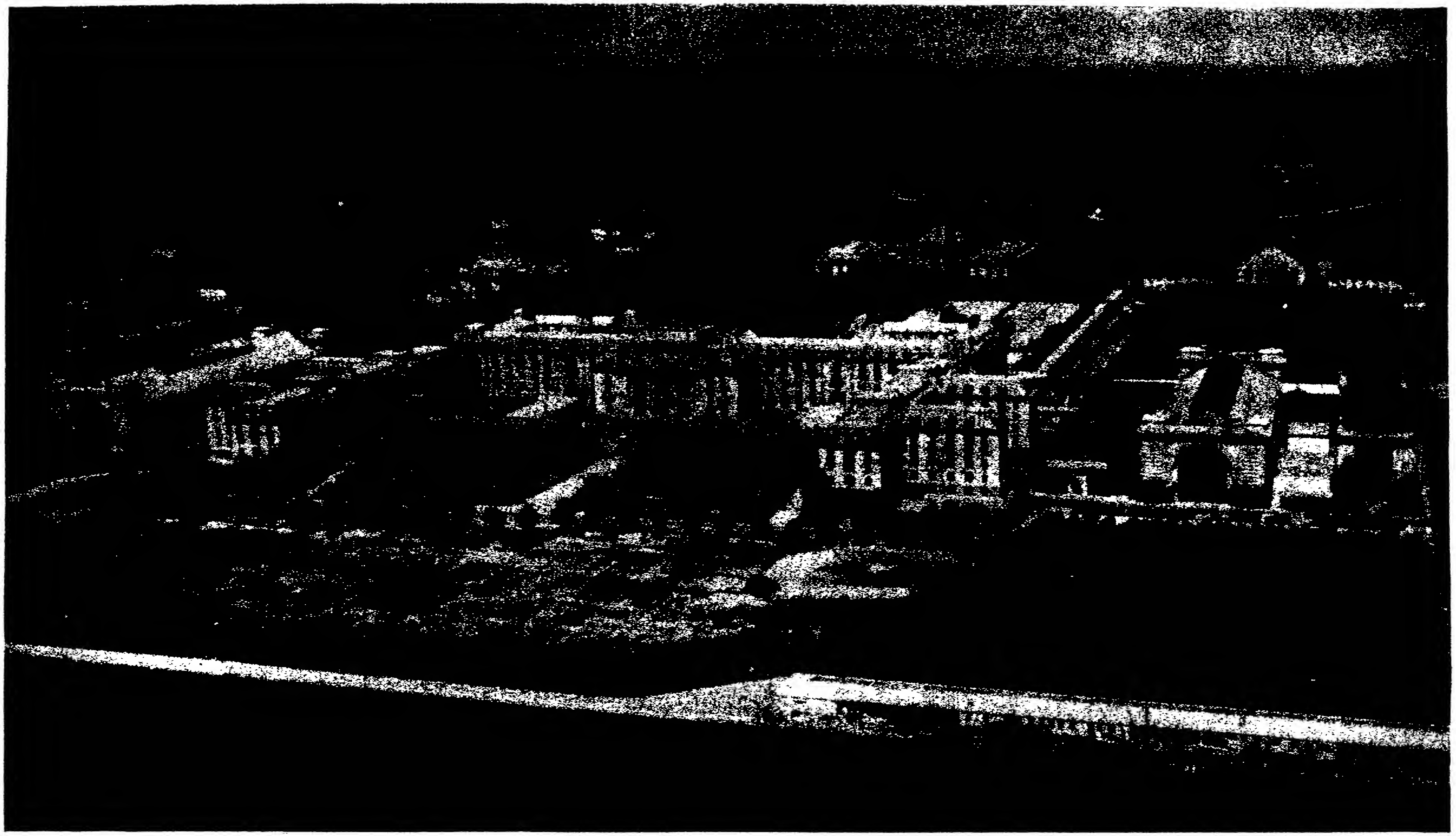
90 YEARS OF SERVICE

Scientific American

SECRETARY of the Navy Claude A. Swanson: To celebrate jointly the 90th anniversary of two American institutions that have contributed so much to the scientific development of our country is peculiarly appropriate. As Secretary of the Navy I am privileged, on behalf of the Navy, to felicitate our civilian scientific colleagues, and to express the assured hope that the Navy and their fellow scientists in private life will continue their scientific progress side by side and to the increased benefit of our whole national life.

ASSISTANT Secretary of the Navy H. L. Roosevelt: It is a pleasing coincidence which couples the career of the United States Naval Academy with the career of SCIENTIFIC AMERICAN. Both emerged, 90 years ago, from small beginnings. The Naval Academy has become the repository of 160 years of naval experience and tradition, in the light of which we train our successive generations of sea officers. SCIENTIFIC AMERICAN contributes to a similar, and in a sense, a more catholic function. In these days of precise machinery, the SCIENTIFIC AMERICAN is a kindred medium for the advancement of knowledge, as this navy issue most amply demonstrates.

ADMIRAL W. H. Standley, Chief of Naval Operations: That science has been the hand-maiden of the Navy during the past 90 years is largely due to the wise foresight of Secretary of the Navy George Bancroft in founding the United States Naval Academy in 1845. Then we had but two reliable sea-going steamers which were considered as merely auxiliary to a Navy of sailing ships. The advances which have meantime transposed our floating forces into marvels of applied science are in great part a product of Naval Academy education combined with practical experience afloat.



THE "CRADLE OF THE NAVY" ON THE SEVERN RIVER

"HE should be the soul of tact, patience, justice, firmness, and charity." John Paul Jones pronounced this dictum as his opinion of the necessary attainments of the naval officer. To this, and others equally sententious by our naval hero, the United States Naval Academy has rigidly adhered for 90 years. From a small beginning in 1845, this institution has grown into this splendid group.

15 Years of Naval Development

Momentous Post-War, Post-Treaty Period . . . Great Advances in Design, Construction, and Personnel Training . . . Science in the Navy

By CAPTAIN JONAS H. INGRAM, U.S.N.

NO similar period in our history, since the advent of steam, has contributed more to the scientific and technical development of our Navy than the past 15 years.

The lessons learned from the World War provided the basis for new ideas and experimentation along varied lines. The composition of our fleet itself was influenced by the practical experiences of war and later by the terms of the Washington Naval Limitation of Arms Treaty in 1921.

Prior to the World War our Navy consisted chiefly of capital ships, some antiquated cruisers, a few destroyers and submarines, and a handful of naval auxiliaries. Naval aviation was in its infancy.

War, with its inevitable increase of naval appropriations, enabled the Navy Department to plan for a balanced fleet of all types as had been the urgent recommendations of the General Board of the Navy for several years.

The organization of the Naval Establishment provides for technical experts, in design and practice, to work out the many scientific details necessary for the development, experimentation, and construction of effective men-of-war.

The officer personnel of the Navy is made up of men who have dedicated their lives to the naval service, the great percentage of whom are graduates of the United States Naval Academy at Annapolis. Many of these graduates are later recalled for a post-graduate course at the Academy and still later sent to such technical schools as Massachusetts Institute of Technology, Columbia, Harvard, for further instruction.

These men have had the advantage of advanced education, travel, contacts abroad, opportunity to see what other nations have, and above all, the deep interest instilled by love of a profession that demands going to sea and operating the ships they may be called upon to fight. In this manner the opportunity is afforded to observe at close range the need for improved methods and the live desire not merely to keep abreast of the times but to set the pace.

The very best example of the professional alertness of the naval officer is his interest in naval aviation. The whole Navy is emphatically air-minded. While only a small percentage of the total number are pilots, every target practice, scouting problem, or grand fleet maneuver has brought home to everyone the possibilities and advantages of a su-

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These are the personal views of the writer and in no way express the official views of the Navy Department.

perior air force. As a consequence, the whole Navy is deeply interested in the design, operation, and tactics of aircraft.

The same interest is apparent in all branches of the profession. While the naval constructor is the designer of ships and responsible for their plans and construction, the line officer is keenly interested and always ready to give practical suggestions for the best possible product. The same interest is evidenced in the engineering, ordnance, navigation, communication, supply, and medical branches. This interest and co-operation between the technical and operative branches of the Navy have been conducive to intelligent co-ordination and productive of most gratifying results.

The Navy is not a Federal bureaucracy inhibited by red tape and lacking in initiative, but, on the contrary, is a live and going organization. It is the result of a gradual evolution of a system over a long period of years, imbued with ideals and traditions of public service, and inspired by the stimulus of selection and promotion on merit.

IN reviewing naval development over a specified period, one naturally turns to the evolution in design, the reasons for types, and the causes for subsequent changes.

The German submarine menace was responsible for the design and rapid building of our "flush deck" destroyers, a seaworthy and effective type, superior in fighting characteristics to their "opposite members" in foreign navies. While this gave us a preponderance of destroyer tonnage at the time, it presented later a serious disadvantage in that they all became over-age by 1933, and in the meantime this important category had been completely neglected in new construction. The recent building program has, however, brought forth a new type that merits much praise. These new craft embody many new features of unusual construction. Armed with five 5-inch double-duty guns, mounted on the center line, that can be used either as anti-aircraft batteries or for horizontal firing against surface vessels, and having two quadruple torpedo tubes on a center line capable of firing to either side, this type of vessel represents a formidable fighting unit. Together with their high speed and efficient depth charge firing device, these new destroyers will command a wholesome respect from enemy submarine craft. (See SCIENTIFIC AMERICAN, September, 1935.—*Ed.*)

The greatest improvement in design has been evidenced in the new ideas incorporated in the capital ships and in the development of the new 10,000-ton, so-called "treaty cruisers."

The war accentuated the dangers of the submarine and mine menace and

"The whole Navy is air-minded"

much experimentation was made on the effect and scope of torpedo and mine explosions. This was accomplished by noting the effect of high explosives on caissons built similar to under-water sections of large ships. As a result of these experiments came intricate underwater compartmentation, air spaces, and double bottoms filled with oil. The combination is as nearly impervious to severe shocks as possible, and tends to localize injury. With the advent of the aerial bomb came the "blister," which is an additional compartmentation outside the outer skin of a vessel and capable of being flooded with sea-water and then pumped dry, giving the additional advantage of keeping a ship on an even keel after sustaining damage. It thus insures an even platform for continued gun fire and prevents loss of stability.

High-angle gun fire and aerial bombs necessitated heavily armored decks in addition to side armor.

The new menace from the air demanded additional defensive strength in anti-aircraft batteries of intermediate caliber and high-angle guns and new, heavy caliber machine guns. The necessity for planes on ships other than plane carriers was responsible for the catapult which literally fires a plane off a ship, giving it a momentum of 60 miles an hour over a space of 60 feet. Stowage space for from three to four planes had to be provided on each ship with efficient means for picking them up at sea under normal conditions or in considerable seaway.

This ready adaptation to new offensive measures was so effective that the battleship continues to be the backbone of the fleet—the toughest ship made, able to give and take more punishment for a longer period than any other type yet projected. (See "Why the Battleship?" by Commander Jonas H. Ingram, July and August, 1934, SCIENTIFIC AMERICAN.—*Ed.*)

The prestige of the battleship has been maintained, not by building new ships—this being contrary to Treaty provisions—but by the modernization of our ships. This work has, in some cases, been so extensive as to include new engines, new boilers, increased elevation of main battery guns, additional deck armor, blisters, re-compartmentation, anti-aircraft batteries, and substitution of the tripod mast for the conventional cage mast, characteristic until recently of American battleships. This last modification was necessitated by the added weight of fire control installation and equipment that were added to the fighting tops. Oil burning and stowage of fuel oil made a major problem in the conversion of some of the older ships. (See also "Modernizing the U. S. S. *Mississippi*," by Captain W. D. Puleston, June, 1934, SCIENTIFIC AMERICAN.—*Ed.*)

The Cruiser. The new 8-inch, 10,000-ton cruisers gave the naval constructor a new field to exploit and a fast, moderately armored, heavily armed ship resulted. In it are embodied all the latest modes of offensive and defensive characteristics. These ships are really the last word in American warship construction and have probably attained the limit of combat strength that their restricted tonnage will permit.

THE Plane Carriers. A plane carrier is essentially a portable aviation field with the attending stowage and repair facilities. It must be capable of high speeds and long cruising radius and, at the same time, have deck space ample to provide take-off and landing area for her planes. It must be large enough to accomplish this under trying weather conditions at sea, and, of course, be capable of carrying a number of planes, fuel, equipment, and spare parts.

Our first two large carriers, the *Lexington* and *Saratoga*, were originally laid down as battle cruisers but due to the Treaty of 1921 were converted into plane carriers. The limited total tonnage for plane carriers made it imperative to spread the allowance over more ships and the recent policy has restricted the size of carriers to 20,000 tons.

The constructor has kept apace of the time not only in ship design but also in the advancement of scientific construction. Extensive experimentation was made in the structural strength of materials and in details of construction

to insure stronger and more efficient structures.

In ship design, from the time the first line is drawn, it is largely a question of compromise as to weight, which includes not only the hull itself, but armor, machinery, armament, fuel capacity, equipage, and the necessary quarters for the accommodation and contentment of personnel.

Research work and experiments have been made in metallurgy with astounding results. Lighter metals have been used as a substitute for steel in many places with a corresponding saving in weights. Considerable improvement has been made in steel and in armor plate. Outstanding, however, have been the results attained from the exhaustive tests on the many phases of electric welding. This scientific development of metal working has practically made the use of rivets obsolete in warship construction, with many attendant advantages.

Some other interesting products of research and tests are: Strength of hull plating in compression; Strength of submarine hulls; Studies of ship vibration; Behavior of corrosion resisting steel in gasoline tanks and in salt-water piping; Extensive revisions of specifications for various types of steel in order that air hardening and resultant brittleness, following welding, might be kept within acceptable limits for ship construction; Development of insulating materials; Perfection of effective anti-fouling paint for ships' bottoms; Development of special type of glass for airport lenses, resulting in marked savings in weight; Completion with refinements in the design of submarine escape apparatus, the "lung"; The progressive development of the underwater design of hulls to avoid resistance by exhaustive tests of models in the model tank at the Washington Navy Yard.

NAVAL aviation first received official recognition in September, 1908. The following 13 years were largely experimental in character though great strides were made during the period of the war and immediately afterwards. It was not until September, 1921, that the formation of the Bureau of Aeronautics was authorized by the President of the United States and Rear Admiral W. A. Moffett, U.S.N., was appointed Chief of that Bureau.

The first turn-table catapult was constructed and installed on the U. S. S. *Maryland* in 1921. Three additional catapults of this type were ordered after the *Maryland* tests, and before these were completed an order for 20 more was placed. Today each battleship and cruiser in the United States Navy carries its complement of aircraft, with planes always ready to be launched from modern, efficient catapults.

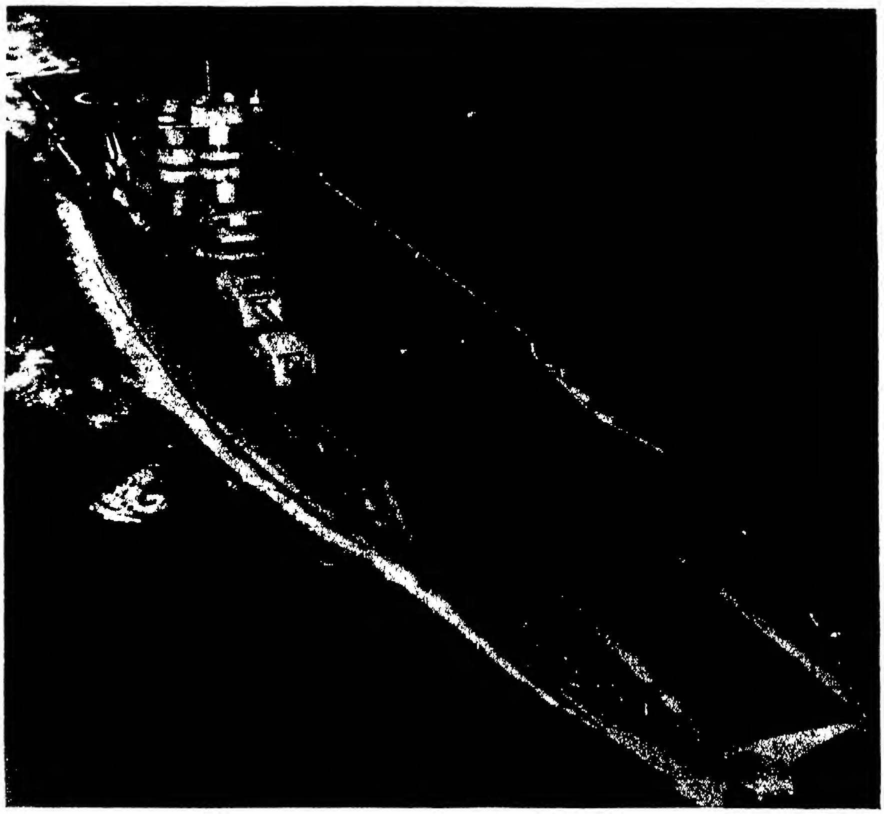
One of the most important post-war achievements was the development of the air-cooled airplane engine. (See "Industry and the Navy," in this issue. —*Ed.*) This power plant, lighter than the water-cooled type, gives much better performance and eliminates the possibility of forced landings due to broken water connections, radiator leaks, and defective water pumps. Air-cooled power plants ranging from 200 to 500 horsepower are now standard in the Navy and are installed in every service type of plane in operation. Another noteworthy advance was the substitution of metal alloys for wood construction. Metal is lighter, stronger, and does not deteriorate so quickly.

During 1928, there were five types of planes in use in the Navy, namely: fighting, observation, torpedo, patrol, and training. Each had its specific duty to perform and was designed especially for that duty. In this connection it should be borne in mind that features of design for Navy planes differ radically from those applied to military and commercial aircraft. Large patrol flying boats are often called upon to land and take off in heavy seas, hence they must be of very rigid construction. Fighting, observation, and torpedo planes are carried aboard ships and are subject to the additional strains of being catapulted and landing into arresting gear. Consequently, they must be of sufficiently rigid construction to withstand being operated in this manner.

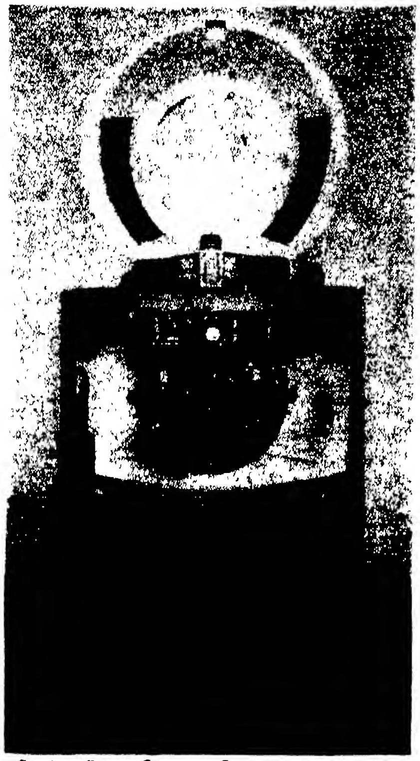
The year 1929 saw the Navy's Five-Year Building Program, as authorized by Act of Congress and approved June 24, 1926, well under way. The progress made during the year in naval aviation continued to demonstrate the wisdom and soundness of the program, since the Navy had on hand or in production aircraft suitable for carrying out any mission which the forces afloat might be called on to accomplish.

THE year 1929 opened with the Fleet's annual cruise in southern waters, participated in for the first time by the two carriers, *Saratoga* and *Lexington*. Together with the battleship and cruiser planes, the carrier planes demonstrated every possible form of offense against surface craft and shore bases. Torpedo planes delivered attacks through smoke screens; fighting planes delivered attacks on surface vessels and shore stations; while radio-equipped observation planes kept the ships constantly informed of all phases of the "war." A night air raid, sent out by one of the carriers while she was yet 150 miles off the coast of Panama, theoretically destroyed the locks. A total of 247 planes took part in the maneuvers and flew 4397 hours over nearly half a million miles in every kind of weather and under varying conditions, without a single serious accident.

Operations during the year showed conclusively the immense value of aircraft carriers, and the authorization of an additional carrier by Congress showed clearly their appreciation of this fact.



U. S. S. *Lexington*—one of the nests of the sea hawks



Courtesy Sperry Gyroscope Company

The Gyro-Compass has successfully passed severe tests by the Navy

Due to the increased reliability and length of life of the American aircraft engine and its marked advancement, the Navy Department was enabled to limit its purchase of spare engines to 50 percent—a distinct economy.

Fast two-seater fighters with retractable landing gears were developed and assigned to the Fleet, and the development of tactics for this type of combat plane was vigorously carried out.

The two-row radial air-cooled engine reached the stage where it could be relied upon as a satisfactory service type power plant.

Fourteen Navy and Marine Corps flyers were saved by emergency parachute jumps during the year, continuing the record of naval aviation of no one having lost his life due to failure of the parachute to function.

The most important event of the fiscal year 1934, looking toward the continued operating efficiency and future expansion of naval aviation, was the passage of the Vinson-Trammell Naval Bill. This legislation authorized the construction of the Navy to Treaty strength in surface ships and the necessary number of aircraft commensurate therewith. The previous aircraft building program, which was enacted in 1926, provided airplanes (1000) only for a Navy of the strength existing in that year. Hence, since 1926 until the passage of the Vinson-Trammell Bill the Navy operated under that 1000-plane limitation.

It was estimated by the Navy Department that a total of approximately 2000 airplanes would be required to equip the existing Navy, the six cruisers, and two aircraft carriers in 1934, and the ships to be built under the Vinson-Trammell Bill, together with necessary tender-based, long-range patrol, bombing squadrons, and other activities. In order to insure the proper and timely supply of airplanes, a five- to seven-year Aircraft Building Program was laid down which provided for the completion of a certain percentage of planes each year.

In September, 1933, a squadron of patrol planes (P2Y-1) flew from Norfolk, Virginia, to Coco Solo, Canal Zone, a distance of over 2059 statute miles—the longest formation flight on record at that time.

Another incident which clearly exemplified the high state of efficiency which had been attained was the flight of a squadron of patrol planes (P2Y-1) from Norfolk to Coco Solo, thence to Acapulco, Mexico, San Diego, California, San Francisco, California, and thence to Pearl Harbor, Hawaii. The last leg of the flight, made in January, 1934, was 2309 statute miles and was flown non-stop and in formation in 24 hours, 45 minutes, thus setting a new record.

On April 9, 1934, the Fleet, consisting of 110 ships, left the West Coast for the East Coast via the Panama Canal, the transit of which was commenced on April 23 and was completed in 47 hours. During the trip between coasts, and while engaging in maneuvers, the airplanes of the *Saratoga*, *Lexington*, and *Langley* flew approximately 1,500,000 miles without a single actual casualty.

In engineering, the American Navy has long been a pioneer, having contributed extensively to this field in design, efficient operation, upkeep, and scientific development. The work of the naval engineer is well known to the profession as he has been closely identified with engineering development since the days of the single-cylinder, simple horizontal engine, operating on 40 pounds of steam pressure supplied from the rectangular type of boiler, to the formidable, high-powered plants of today. The engineering plants of our modern capital ships are illustrative and typical of the remarkable program of the past 15 years in Naval engineering development.

Since 1920, the following battleships have been completed:

Tennessee	(1920)
Maryland	(1921)
California	(1921)
Colorado	(1923)
West Virginia	(1923)

All of these were of the so-called "electric drive" type having electric reduction between turbines and propeller shafts. All of these had steam pressures

Important Navy Achievements

(Prepared

Centrifugal condensate pumps and air ejectors have replaced main air pumps.

Centrifugal pumps have been adopted for water service having submerged suction.

Positive displacement rotary pumps are used for fuel oil.

Direct-drive centrifugal blowers have been superseded by direct-drive propeller type and geared centrifugal type.

Service air compressors have been changed to the geared turbine or motor-driven two-stage types. High pressure air compressors have been changed from reciprocating to turbine drive.

Whistles have been changed from the bell to the diaphragm type.

Improvement has been made in condensers which now operate at higher rates of heat transfer with better disposition of transfer surface and lower condensate pressure.

Evaporators have increased in capacity and simplicity; the high pressure type has disappeared from service.

Mechanical pressure atomization of fuel oil has remained in use. The capacity and overall efficiency of burning oil have been increased through refinements in the atomizer and register design.

Lubricating oils have been reclassified and a work factor method of evaluation adopted. The work factor and other tests have been revised upward to more than double the quality.

Packings have been improved and developed to increase their endurance life from 1500 hours to about 6000 hours.

The tests for refractories have been revised to eliminate all but the highest quality commercial No. 1.

Until 1925, magnesia was used for heat insulation for practically all purposes. Since then, improved high-temperature insulations have been developed and adopted.

Chromium-steel for turbine blading has given a material highly resistant to steam erosion, shock, and fatigue.

Steels containing molybdenum have been adopted for high temperature use up to 850 degrees Fahrenheit.

High chromium-steel alloys have been used to resist scaling at high temperatures in boilers and superheaters.

Silicon-bronzes have been developed as substitutes for bronzes containing tin and zinc. These are weldable.

The development of new silver solder has permitted the adoption of new designs of streamline fittings and the use of thinner tubing.

The quality of Monel metal has been improved, resulting in the production of better castings and permit-

Of Industrial Significance

Ingram)

ting its fabrication by electric welding.

The use of the 18-8 type of corrosion-resisting steel for boiler burner sprayer plates has resulted in elimination of breakage and reduction of erosion.

The use of metal spray has been found satisfactory for restoring worn parts in certain applications.

A cobalt-chromium-tungsten alloy has been developed for application by gas welding to surfaces of valve disks, valve seats, and other surfaces subjected to steam erosion and frictional wear.

Aluminum alloys resistant to corrosion, especially of the inter-granular type, have permitted their substitution for heavier metals both in cast and wrought forms.

Improved methods of fabricating copper-nickel tubing have resulted in tubes more free from mechanical defects and permitting their use as condenser tubing. Tests indicate the copper-nickel tube to have a service life at least twice that expected from admiralty tubing and to permit higher water velocities without injury.

Free machining, corrosion-resisting steel is suitable for threaded parts such as valve stems, bolts, and nuts.

The use of beryllium as a hardening agent has been found an improvement where the metal so hardened is subjected to vibration such as in diaphragms of signal horns.

The use of seamless, forged, boiler drums has permitted the adoption of higher steam pressures. Since the development of electric welding and the non-destructive examinations by X-ray and gamma ray, the welded boiler drums have superseded the seamless forged drums.

The use of X-ray and gamma-ray examination for important steel castings has increased the reliability of these castings.

Turbine efficiencies have been increased by use of higher speeds permitted by the development of double reduction gears.

The development and adoption of economizers, air pre-heaters, and enclosed feed systems have improved boiler efficiency and life.

Ball bearings have been more generally used in restricted applications to reduce friction.

The development of welded union end pipe fittings in small sizes and the extension of welded pipe joints have served to reduce weight.

The above items will serve to give a general idea of the progress that has been made to date in marine engineering. Needless to say, such a summary must be very incomplete and sketchy for the reason that practically every part of the engineering plant and the materials used therein are constantly undergoing changes and improvements that would be impossible to cover fully in a brief listing such as this.

of 300 pounds or over and a superheat not exceeding 75°, Fahrenheit. Large tube, B.&W. oil-burning boilers were used. The modernization of the *Texas* and *New York* did not change the main engines but changed the boilers to the Dyson type with superheater. The modernization of the *New Mexico* changed the main engines to turbine drive and changed the boilers to the small tube, express type.

In 1922, the *Langley* was commissioned as the first airplane carrier. This ship was originally the *Jupiter* on which the first electric reduction was installed experimentally and retained. The airplane carriers *Lexington* and *Saratoga* were converted from the partially built battle cruisers. These vessels are electrically driven and each has 180,000 designed engine horsepower. The development of electric drive probably reached its peak in these vessels.

All recent heavy and light cruisers and destroyers have geared turbine drive.

The Diesel engines on submarines have been constantly improved to obtain increased power, ruggedness, reliability, and efficiency. Airless (solid) injection engines are the latest type developed for these vessels.

Refinement in turbine design has resulted in safe operation at high speeds with a consequent reduction in weight. Illustrative of this are the ship's service generators. A 300 kilowatt turbo-generator purchased in 1920 weighed 23,000 pounds. During 1933 a 400 kilowatt set was purchased which weighed 24,075 pounds.

During the last few years, the use of alternating current instead of direct current for ship's lighting and power has been generally adopted. This has resulted in greater reliability due to the squirrel cage induction motors and consequent freedom from commutator troubles; simplification of motor control equipment; and greater flexibility in a system which permits the generation and distribution of current at a higher voltage, thus saving considerable copper and yet permitting utilization of the energy at different voltages (through transformers) for the various power applications.

Saving of weight has been an important accomplishment in marine engineering without sacrificing reliability and ruggedness. Many parts, such as electrical fittings, instruments, gage cases, and thermometers, which were formerly made of heavier metals, were first changed to an aluminum alloy of about one third the weight. Later these parts were changed to molded phenolic material with a weight only half that of aluminum. Development has also decreased the weight without loss and, in some cases, made a gain in efficiency in structural parts, refractories, and heat insulation.

The first heat- and flame-resistant electric cables were installed in 1929. The development of these cables has been continuous. Aside from the greater reliability of these cables in abnormally heated spaces, the higher load ratings permitted result in a further saving of weight by the saving in copper.

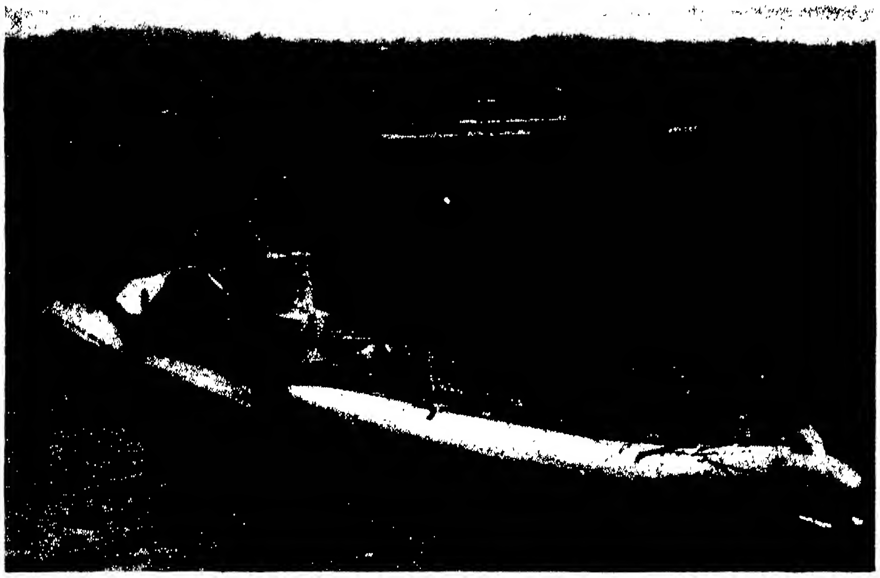
During the last 15 years the developments listed in the accompanying tabulation, among others, have been made in the auxiliary machinery.

DURING this same period, the Navy has been constantly in the forefront of communication development. It has contributed to the development in many ways, but principally through the drawing of specifications and the purchase of material which have made practicable the production of improved devices.

Within 15 years, obsolete spark and

Courtesy General Electric Company

A group of electric arc-welding units developed for the Navy



One of the Navy's submarines—the U. S. S. *Bonita*

are radio transmitters have been replaced with vacuum tube transmitters. Radio receivers have been developed to provide the greatest practicable sensitivity and selectivity. The behavior of high frequencies (short waves) has been thoroughly explored, the laws have been derived, and a whole new section of the radio spectrum has been opened to practical use. The Navy has applied these frequencies to long-distance communication. Stabilization of frequency adjustment of radio transmitters has been achieved through development of quartz crystals. Radio direction finders have been developed from the crude devices of the war period to reliable instruments and they have been applied to navigational purposes as well as to the recording of electrical disturbances for tracing the path of storms. Automatic high-speed radio transmission and reception have been developed on a practical basis. Radio photography has been developed and put to practical use, as, for example, in sending weather maps. Multiplexing, or simultaneous transmission and reception, on several radio circuits has been perfected and has been applied, not only on shore, but in vessels. Depth finders or indicators have been perfected and ocean bottom contours are being determined by soundings taken from rapidly moving vessels.

The time signal service has been improved and expanded. Six standard time signals are broadcast daily from the Naval Observatory in Washington through Arlington and Annapolis and are re-broadcast by Mare Island, California, and Honolulu, T. H., with an extremely low average error. The service of weather and hydrographic broadcasts has been improved and extended. Eighty-eight bulletins are broadcast through 39 stations. The direction-finder service along the coasts and at harbor entrances furnishes a quarter of a million bearings annually to ships and aircraft. The naval communication service handles messages for all departments and agencies of the government, effecting savings in commercial charges of over three quarters of a million dollars annually.

Naval officers have played a leading part in all national and international communication affairs. The first chairman of the Federal Radio Commission was a naval officer and a naval officer was furnished as their first technical advisor. The Navy has assisted in representing the nation at each of the dozen or more international conferences held on communications since the World War. The Navy has assisted at all national conferences on communications and has materially assisted in formulating the present frequency allocation.

A volunteer naval communication reserve has been organized, with a membership of 700 officers and 3900 men, throughout the country. About two hours per week are devoted to drills from 32 Navy-owned control stations and about 2000 privately-owned amateur stations. A very complete organization for communication in emergencies and disasters is maintained and has been used most effectively on several occasions.

FLEET Tactics should be so designed as to take the maximum advantage of every naval characteristic of the Fleet as a whole and of its separate units in order that the Fleet may be able to utilize its every ounce of offensive or defensive power to advantage when it is called upon to use force.

Up to the time of the World War, our Fleet was making a slow but steady growth. The major effort was to build battleships and to train personnel. The growth of the Fleet and resulting expansion in the allowed personnel required that the maximum training effort be in fundamentals. The result was that training in Fleet Tactics was limited in scope.

The mission of our Navy during the World War was to provide troops and supplies with safe conduct through "submarine zones," to combat the submarine menace, and to augment the British Grand Fleet with battleships.

The close of the World War found our Navy with a large number of battleships (some being beyond a useful age) and destroyers, and with a building program under way which, had it been completed, would have made our Navy the strongest in the world, especially in battleships and destroyers. Our officers were rapidly digesting the naval lessons of the war and applying these lessons to our Fleet. One of these lessons was that aircraft had come to stay and was a very important auxiliary to any Fleet. Fleet Tactics, designed to fit our existing Fleet and ships building, were beginning to take shape. Demobilization was under way, and the importance of training the individual and the single unit of the Fleet gave way to training the Fleet as a Fleet.

Then came the Washington Disarmament Conference and our actual superiority in battleships over other World Powers gave way to equality. This brought our naval tacticians face to face with a new problem. The battleship is, and has been, the backbone of the Fleet. In this type of ship we were at maximum strength allowed by the Treaty; we had a large number of destroyers, many of them being of wartime construction; experimentation had demonstrated the importance of having aircraft with the Fleet and airplane carriers to carry them there; we had few cruisers and no one knew just what kind of vessel the newly proposed 10,000-ton 8-inch-gun cruiser would be. The problem was to revise our tactics to meet the situation and to look forward to applying our tactics to a well-balanced Fleet, when we might get one.

The fundamental historical principles of Naval Tactics are still sound, but the application of these principles to the Fleet of the present day is a task which is unending. Therefore, the development of our Fleet Tactics to meet existing conditions and to meet probable new naval developments is one of the major naval achievements since the World War.

As long as we are not a seafaring nation, we must continue the individual training of raw personnel. This training is for the most part to produce a highly skilled personnel. Scientific naval developments demand this, but along with the training of new personnel the advanced training of the older personnel must go forward in order that our Fleet as a whole may be ready to carry out its mission.

OUR POINT OF VIEW

A Worker is Worthy . . .

"I AM not so sure I shall bother to submit a bid for any more Navy business. Why should I? After doing the research necessary to meet their rigid specifications, all I can get out of it is a 10 percent profit. I stand the great cost of the research and show a net loss on the deal. It's not even a good gamble for companies such as ours that most often must develop each product sold to the Navy under each new contract."

Thus spoke the president of one firm that for years had been making an outstanding and vital product for naval vessels. In many other firms the editors found the same feeling existing in regard to section 3b of the Vinson Act which was approved March 27, 1934. Under it, as the statement of the manufacturer mentioned above indicates, the contracting company is required "To pay into the Treasury profit . . . in excess of 10 per centum of the total contract price, such amount to become the property of the United States . . ."

Why both the Navy and private industry should have been saddled with this handicap we do not know. The Army has no such provision, nor has the Coast Guard or any other Government service. Thus, in the first place, it is discriminatory. More important is the fact that it discourages simplification of existing equipment and materials and the development of new devices to make the Navy a more efficient unit. Initiative has no incentive when hope of a possible reward is so small. We say *possible* because it is public knowledge that not all development work—sometimes costing hundreds of thousands—results in a product that is satisfactory. Indeed, there is too often a net loss in companies having one success and several failures. Yet purveyors to the Navy must take that chance if they expect to meet the very rigid demands of the Navy specifications. The profit limitation, therefore, can not but retard naval progress at a time when, because of naval treaties, we must pack every possible ounce of power and efficiency in the tonnage we can build under those treaties.

For special equipment, and instruments in particular, the Navy is often the sole or main customer. Consideration of these facts has prompted proposal of an amendment to the Act to exclude instrument makers from the 10 percent limitation of Section 3b. A prominent executive, president of a company whose instruments are vital to the Navy, who was questioned at great length before the House committee on Naval Affairs regarding this proposed amendment, reports that the Committee gave him a fair hearing and reported favorably on the amendment. "My experience before the Committee," he says, "shows me how responsive the legislative branch of our Government is to the needs of business provided business has the intelligence to present its views intelligently." The bill has passed the House and will be taken up by the Senate early in the next session of Congress.

It should be passed by all means: otherwise the Navy's efficiency will suffer sorely. "This pursuit of every possible opportunity for adding to the effectiveness of the national defense as well as other scientific applications," the executive told the Committee, "cannot continue unless the inventors, the engineers, and the organizations engaged in this kind of work have the hope, at least, of a sufficient compensation for their successful inventions to outweigh the losses on their inevitable and unavoidable failures." Progress depends on the creative mind. The man of creative mind is adventurous. To the adventurous, the offer of a doubtful reward, such as the 10 percent on an unknown cost allowance, is really no reward and amounts to a complete withdrawal of all incentive.

Conservation Gains

ONE of the main reasons for the alarming decline of wildlife in the United States—a subject frequently discussed in these pages—is the lack of organization on the part of sportsmen. There are millions of individuals interested in fish and game, yet there is no articulate voice to speak for them. There is ample material for the building of a powerful machine, but no guiding spirit for its assembly and subsequent operation.

Now, however, there appears a light in the cloudy picture of conservation. Jay N. ("Ding") Darling, well known for his two years of work as the Chief of the Bureau of Biological Survey, appears as one of the guiding spirits of the American Wildlife Institute. Associated with the group are such nationally known figures as Walter P. Chrysler, Thomas H. Beck, Powel Crosley, Jr., and others. The function of this organization is to influence and guide the existing but inarticulate sentiment for the preservation of wildlife, to the end that the sportsmen and other interested parties may coordinate their efforts and bring to bear their massed force to carry out well-considered programs of conservation. An auspicious start has been made: There is every indication of well-merited success.

The Unforeseen

BRITAIN awoke to the fact, one day quite recently, that she had been checkmated in the Mediterranean. As part of Italy's long-view strategy, that country's military chiefs had worked out in 1930 a plan for nullifying the military value of Malta, a British island base situated between Sicily and the African coast. Apparently Britain had not suspected such a plan until it came to light in the Anglo-Italian crisis over the Ethiopian problem In England, the news of this plan, coupled with the antagonism of the Italian press, caused consternation. "Why haven't we built enough ships to command such a situation?" the people wanted to know. "What is wrong with our Navy?" "Can Gibraltar and Suez maintain our hold on the Mediterranean?" "Why has the Admiralty been so short-sighted?"

Here was an unforeseen situation calling for a great deal of diplomatic squirming and military maneuvering. As this is being written, no untoward incident has resulted, but it is conceivable now that some slight spark may yet start the flames of war in the Mediterranean. That would, indeed, be no less regrettable than disastrous; and it is earnestly hoped that the whole matter may be settled on a friendly basis to the entire satisfaction of all.

Nevertheless, there is a moral. Had Britain been unquestionably supreme on the seas, there may have been no threat, and her admonitions may have assured peace. But, according to Britishers, she has permitted her navy to become weakened, and the voice she raises in the cause of international peace correspondingly puny.

Often in human affairs it is the unforeseen that must be guarded against; *always* is this so in international jockeying for military position. "In times of peace prepare for war" is a truism to which, in urging continued support of our American naval building program, this journal conditionally subscribes. We would modify it to read: "In time of peace: prepare to keep out of war!"

THE PROBLEM OF THE

Pacific Naval Problems Have Their Foundations in the History of International Meddling and Muddling . . . A Way Out

By ORSON D. MUNN

CHINA'S WEAKNESS. The military weakness of China is the basic cause of the present chaotic situation in the Far East. The helplessness of China is no new condition. Throughout the 19th Century, China was bullied in turn by all the great European powers. Unable to offer any effective military resistance, China was obliged to engage in the very dangerous policy of playing off one European power against another, and when this policy failed she resorted to diplomatic delays and evasions in complying with treaties wrung from her by force. In addition to these peaceful measures, China made one desperate but ineffective resort to arms, the Boxer outbreak of 1900, which was speedily crushed by a foreign coalition. Since that defeat, China has not dared to oppose any Great Power forcibly. She has, however, at various times employed the commercial boycott with extraordinary success.

JAPAN'S STRENGTH. In startling contrast to China's military weakness has been the rapid military development of Japan, who has assimilated the military methods of Europe with almost miraculous swiftness. Japan had military traditions to build upon, and her leaders were wise enough to secure German officers to instruct her army and British officers to train her navy in the modern military science and art.

By this rapid transformation of her military system, Japan alone of all the Asiatic powers succeeded in preserving her entire independence and the freedom to develop her national life without foreign interference. Probably never in the world's history have two neighboring States presented such a sharp contrast, and those advocates of national disarmament as a possible road to peace should consider the recent and present condition of these two ancient Asiatic peoples.

INTERESTS OF OTHER POWERS—RUSSIA. Russia is at once a powerful European and Asian state. Under the Emperors her slow glacial-like expansion excited the fears of Europe and Asia. The European powers were unable to prevent her expansion in the Far East, but modernized Japan in a series of victories on land and sea in 1904-5 defeated the armies and fleets of the previously dreaded Eurasian colossus and halted the advance of the Czars in the Far East.

GREAT BRITAIN. The interest of Great Britain in the Far East is of long standing. She has established herself at Hong Kong, and spread into the Yangtze valley which in due course was generally recognized in Europe as a British "sphere of influence." In the last quarter of the 19th Century the main British problem was to guard against the rapid advance of Russia. She was able to hold her own with the Czars. But the rapid growth of the German nation and navy forced her to ally herself with Japan in order that she might prepare to hold the North Sea against the German naval menace. Japan freed Great Britain of the Russian menace, but Japan's success against Russia also relieved Germany of the threat to her eastern frontiers by the Russian army. This, in turn, enabled Germany to devote more money to her navy, so that in the end Britain probably lost much more than she gained by the victory of Japan over Russia.

CORDELL HULL

SIR SAMUEL HOARE

The solution is in their hands

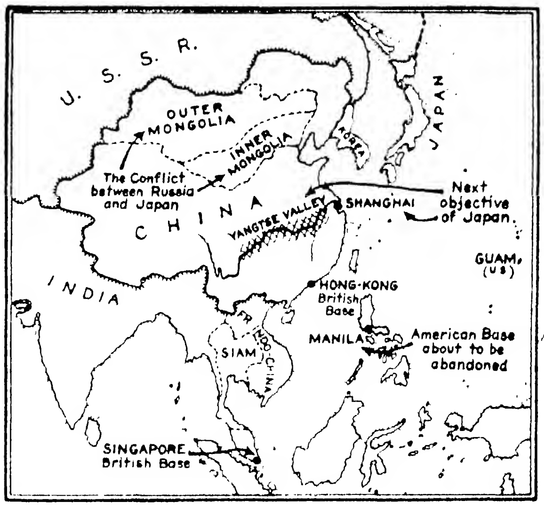
THE UNITED STATES. American interest in China commenced soon after our independence; Yankee tea ships from Marblehead, Salem, and Boston carried our new flag to the Far East. Our infant Navy was called upon to send men-of-war to protect our shipping in the Far East just as it had despatched Preble's squadron to the Mediterranean to protect our merchantmen from the Barbary pirates. In addition, our naval vessels assisted in opening the Chinese and Japanese ports to modern commerce about the middle of the last century.

THE OPEN DOOR. Under McKinley and John Hay we took the lead in formulating the Open Door policy. After much negotiation we gained the reluctant consent of Russia, France, and Germany to this new system; Great Britain was prepared to continue the old European method of delimiting spheres of influence or subscribe to the Open Door proposal. In the end she co-operated with the United States in securing the adherence of the Continental Powers to this new doctrine with the proviso that there would be no interference with already existing spheres of influence.

While Hay was negotiating, Japan was busily preparing her army and fleet to resist the advance of Russia into Korea. She had been robbed of the fruits of her victory over China in 1895 by the joint action of Russia, Germany, and France, and felt keenly a resentment she dared not at that time openly avow.

OPEN DOOR PRESERVES CHINA FOR JAPAN. John Hay's doctrine delayed the dismemberment of China until the consequences of the Japanese victory over Russia entirely changed the Far

FAR EAST*



Eastern situation. Japan took the place of Russia as the most aggressive power in northern China, while the rivalries in western Europe preceding the World War forced them to moderate their activities in the Far East. Thus by a very curious cycle of events, Hay's Open Door policy preserved China from Europe only that it might fall under the control of Japan.

OUR GROWING INTEREST IN THE FAR EAST. Our Asiatic Squadron had for several generations been stationed in Asiatic waters, laying up during the winters in the mud docks of the Pechili before modern port facilities were available. In later years they based on friendly neutral harbors like Hong Kong. And it was from this port in the spring of 1898 that Dewey took our squadron that destroyed the Spanish fleet and captured Manila Bay. We purchased the Philippines from Spain in the treaty that followed this victory. By the acquisition of these islands we gained an American base of operations for commerce or war in the Far East.

KOKI HIROTA

The director of the destinies of Nippon

THE U. S. AND JAPAN IN THE WORLD WAR. Thus the two decades before the World War saw the slow decline of European and the gradual increase of American and Japanese influence in the western Pacific. During the World War the prestige and power of America and Japan increased at the expense of the five great European states that had previously dominated the Far Eastern situation.

LANSING-ISHII AGREEMENT. Japan's contribution to the Allies in the World War, though of great value, cost her little in lives and money; nor did Japan's exertions during that war prevent her putting great pressure on China that culminated in the famous 21 demands of 1915. The provisions of this secret treaty would have definitely established Japanese suzerainty over China. After we entered the war, Japan was able by shrewd bargaining to negotiate the Lansing-Ishii agreement with us in which we almost agreed to recognize her as the dominant nation in the Far East. The language in that document was vague but it is probably true that the Japanese government at that time sincerely believed we had recognized their predominant position in the Far East. Nevertheless, at the Versailles treaty making, we supported China against these Japanese demands.

AFTER THE WORLD WAR. In 1921-2 the Washington Arms Conference substituted the Four Party Treaty for the Anglo-Japanese alliance, restricted the fortifications in the Far East, and established the 5-5-3 naval ratio in capital ships and aircraft carriers. These limitations were extended in the London conference of 1930 to all classes of ships.

THE PRESENT SITUATION. In spite of the efforts of the three naval powers—Britain, Japan, and the United States—to settle the Far Eastern question by treaties and naval limitations, the problem has continued to vex the chancellories of the world. Today it is probably further from a settlement than at any time since 1900.

RUSSIA AND JAPAN IN THE MONGOLIAS. Amid all the domestic upheavals that followed from the World War, Soviet Russia has retained a large interest in the Far East. Only recently the Soviet government has announced her intention to preserve every inch of her own soil. In addition to her own territory the Soviets have a benevolent, almost paternal, interest in Outer Mongolia which is the only province outside of Russia proper to establish the Soviet form of government. Adjoining Outer Mongolia is Inner Mongolia that lies on the northwestern flank of northern China through which Japan must pass in her advance from Manchuria (Manchukuo) into China proper. Japanese army officers are too wise to leave a long line of communication exposed to a flank attack from Russia, so they are now engaged in securing Inner Mongolia and establishing outposts in Outer Mongolia. The Soviets are naturally encouraging the Mongols, who are nominally under the Chinese government, to resist the Japanese efforts. Thus we may see a repetition of the situation in the Russo-Japanese war, where Japan and Russia fought to decide which should gain a Chinese province while the helpless Chinese could do nothing but furnish the battlefields and the innocently involved non-combatants.

OTHER COMPLICATIONS. Russia and Japan have several other issues in dispute including the ill-defined frontier between "Manchukuo" and Siberia and the rivalries among their fishermen. Russia is in a poor condition to oppose Japan because her European frontiers are menaced by the secret agreement known to exist between Germany and Poland, and the probable disinclination of France to go to the assistance of Russia in the event of hostilities arising in eastern Europe. The embarrassing situation of Russia has encouraged Japan to take high-handed measures with the Soviet authority in the Far East. Other potential friends of Russia have hesitated to support her claims because of their fears that Russia as an ally would take advantage of her position to propagate the Soviet ideas of government among their people.

GREAT BRITAIN AND THE UNITED STATES. Great Britain has the most to lose by the advance of Japan into China which would be followed by the gradual eclipse of British trade in the Yangtze valley. The succession of crises in Europe has deterred the British government from taking a more positive stand against Japanese encroachments, and it is doubtful if she could do more than lend her bases and some of her light naval forces and aviation for active opposition to Japan in the Far East.

The United States, thanks to its dis-

(Please turn to page 283)

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*See: "Naval Adequacy," by Captain N. H. Goss, *Scientific American*, September, October, November, December, 1928 and January, 1929; also "Our Third-Rate Navy Could Not Fight Japan," by F. D. McHugh, *Scientific American*, May, 1933.

The traditions of the Academy and of the Service, and a life-time of devotion to an ideal

ANNAPOLIS—

BECAUSE to us the Academy stands for solid American ideals and patriotism; because it is the foundation stone of our wall of national defense; and, further, because the anniversaries of that noble institution and of this journal coincide almost to the month, we are glad to present the accompanying intimate word picture of the Academy and its mission as a guide to fathers and sons.

Captain Jonas H. Ingram, U. S. N., graduated from the United States Naval Academy in the class of 1907, being a member of one of the greatest athletic families ever attending Annapolis. Since then, Captain Ingram has coached football at the Academy for many years having been, in succession: Field Coach, Head Coach, Director of Football, and Director of Athletics. He has been a discipline officer, instructor and member of the Academic Board at Annapolis and probably has had as much experience with the development of the school as any officer in the Navy, so is well qualified to write on the Naval Academy.—*The Editor.*

NINE decades ago, under the direction of President Polk, Secretary of the Navy George Bancroft established the United States Naval Academy at Annapolis, Maryland, to train naval cadets as future officers of the Navy. On October 10, 1935, was celebrated the Ninetieth Anniversary of the opening of that school in small buildings on the Severn River. That group has been replaced and expanded during the years, and today the Naval Academy is composed of well-planned, commodious buildings of rugged architecture surrounded by beautiful grounds. On every side are reminders of the Navy and its development. Relics of the valiant sailing ships of its early days are flanked by those of early steam vessels whose development necessitated the founding of the Academy. In sharp contrast to them are modern ships and airplanes evidencing the strides the Navy has made as the nation's first line of defense. The halls fairly shout the traditions of the sea. Nothing seems to have been omitted for the welfare, education, and physical development of the young man so fortunate as to be successful in entering these historic grounds.

The mission of the institution is to give the mental and physical groundwork necessary for the development of a naval officer but in doing this, it is not so different from other institutions such as Princeton, Virginia, Michigan, or Stanford. The course is naturally limited in comparison, but there is little given at the Naval Academy that will not be an asset to a man in any walk of life. The Naval Academy graduate leaves Annapolis carrying less than the university graduate along some lines but more along others. It is not believed that, for the equipment to face the stern realities of life, the Naval Academy graduate will suffer any by comparison.

The Naval Academy does not graduate specialists in any particular field. The first two years' course corresponds in general with the course at any college, with the exception that mathematics is stressed. The following two years divert more from the normal and the course goes into navigation, gunnery, steam engineering, electricity, government and economics, and aviation, none of which will be a drawback to a person in civil life but, on the other hand, may prove to be an asset.

It is shown, therefore, that one does not necessarily submerge himself on entering the Naval Academy nor is it necessary for every midshipman to consecrate his future to the Navy.

The normal capacity of the Institution is about 2400 and the present law provides for the strength each year being in the neighborhood of 1700. However, it is expected that in the near future the Congress will increase the appointments allocated to fill the institution to its normal capacity of about 2400 midshipmen.

IT is believed that the Naval Academy graduate can not but benefit by the discipline, training, physical care, sea cruises, and character-development that the course offers.

Now consider that those elected to enter are not only given a free scholarship by your government but actually receive pay for going—the pay of a midshipman being 780 dollars a year, plus 80 cents a day for rations, commencing at the date of his admission, and is sufficient to meet all his expenses while at the Naval Academy. Furthermore, the government allows the candidates on entrance five cents a mile for traveling expenses from their home to the Naval Academy.

This looks like something too good to be true and like every other good thing has its jokers. Here they are: 1, Nomination; 2, Methods of admission; 3, Mental requirements; 4, Physical requirements; 5, Entrance. All are hurdles, but none that cannot be surmounted by the boy who has the determination and get-up-and-go (provided, of course, he is physically sound) to achieve the goal.

First, the nomination. The students of the Naval Academy are all midshipmen—this term being passed down to us from the British service and signifying an embryo officer. A midshipman is an officer in a qualified sense. He ranks after a commissioned warrant officer, and ahead of a warrant officer in the Navy. Three midshipmen are allowed for each Senator, Representative, Delegate in Congress, and the Vice-President; five for the District of Columbia; and 15 are appointed each year from the United States at large. The appointments from the District of Columbia and 15 each year at large are made by the President. It is the custom of Presidents to give the appointment

MAKER OF MEN

The Mission of the Naval Academy . . . Opportunity . . . Romance . . . Adventure . . . Future . . . Character-Building and Education

By CAPTAIN JONAS H. INGRAM, U. S. N.

of midshipmen at large to the sons of officers and enlisted men of the Regular Army, Navy, and Marine Corps, for the reason that officers and enlisted men, owing to the nature of their duties, are unable to establish permanent residences and thus be in a position to secure nominations for their sons from Senators and Congressmen. The vacancies from the District of Columbia are filled by a competitive examination of candidates residing in the District.

In addition to this, the law authorizes the appointment of 100 enlisted men of the Navy each year; 25 from the enlisted men of Naval Reserve and Marine Corps Reserve; 40 from sons of deceased officers or men of the World War; four from Puerto Rico; and four from the Philippine Islands, one for each class, but these last-named are not entitled to commissions. All candidates are required to be citizens of the United States and must be not less than 16 years of age nor more than 20 years of age on April 1 of the calendar year in which they enter. Candidates must be unmarried, and remain so before graduation or the penalty is dismissal.

THERE are two dates set for mental examination for entrance under the supervision of the Civil Service Commission at specified points all over the country. The papers are marked at the Naval Academy. Those qualifying mentally are entitled to appointment in order of nomination and will be notified when to report to the Naval Academy for physical examination, and if physically qualified will be appointed and enter.

Each Senator and Congressman may nominate one principal and three alternates for each vacancy he may have.

The Academic Board will consider and may admit without mental examination—under certain rules—a candidate who presents a properly attested certificate that he is or has been a regularly enrolled student in good standing without condition in a university, college, or technical school accredited by the United States Naval Academy.

The average boy, therefore, has the following choice of methods for getting nominated for entrance:

Through his Senator or Congressman. First, ascertain if they have vacancies. These nominations are sometimes political but at other times are open to a competitive examination. Influential men in the community can give much aid. Perseverance and persistence on the part of the boy usually wins out in this case. Never give up. Take alternates nominations. Prepare to pass the examination and, if successful, the same determination in securing the final nomination will be productive of results.

Failing in this, the next best method is to enlist in the Naval Reserve. After being in the reserve for a year, one is entitled to take a competitive examination for nomination, the first 25 contestants passing in order of examination merit getting the call.

The last method is to enlist in the Navy and serve for one year on a seagoing ship. Men of the Navy who meet the qualifications are then sent to school to prepare for the examinations, and the first hundred to pass in order of merit win the appointments.

With these three avenues of entrance open to the American youth it is believed that any boy with the courage and grit to follow up and keep plugging can win for himself the right to be appointed a midshipman at Annapolis.

Preparation in fundamentals is essential and a good school education is necessary to pass the examinations with a high average. An average boy can accomplish this if he is diligent, applies himself, and keeps his eye open to every opportunity.

The physical examination for entrance is rigid and any youth who contemplates entrance should apply to the nearest Navy Recruiting Station for a physical examination. Much trouble will be eliminated if one's true physical status is first determined, failure to pass the color test or some minor organic defect being sufficient for rejection.

CANDIDATES who meet the mental, moral, and physical requirements will receive appointments as midshipmen and be admitted as such to the Naval Academy. Each candidate for midshipman will be required to sign articles (with consent of parent or guardian) by which he binds himself to serve in the United States Navy during the pleasure of the President of the United States (including his time of probation at the Naval Academy), unless sooner discharged. The candidate makes a cash entrance deposit of 100 dollars and then takes his oath of allegiance, given by the Superintendent of the Academy. This amount of money goes for the partial payment on the initial outfit of the midshipman. The Government advances 250 dollars which is later deducted from his regular pay. This takes the boy into the Academy as a full-fledged midshipman in Uncle Sam's Navy.

The average midshipman undergoes a radical change during the first two

Sailboats used for training midshipmen at the Naval Academy

"Stand, Navy, down the field . . ."

weeks of his plebe, or first, summer. A short hair cut, ungainly sailors' garb, regular hours, routine drills and exercises, good food, and strict discipline all have their effects. After this period, plebes are "shaken down" and the life becomes more normal and regular. Nothing is left undone to prepare the summer plebe to join up and take his place in the regiment by the beginning of the Academic year on about October first. Uniforms are fitted, military precision in drills attained, naval etiquette and phraseology partially mastered, rudiments of drawing and modern languages learned, swimming tests and athletic tryouts given. In fact, the crude material is gone over and polished in three intensive months of training so that by the time the upper classmen return from leave, it is difficult to distinguish the trim plebe from his seniors other than by their service stripes.

WITH the opening of the school year, the plebe is engulfed in the activities of the regular school year. Studies and the curriculum are a maze. Football starts with a bang and lots of enthusiasm. This is a trying period and one where both feet must be kept on the ground and every opportunity taken to study and get the hang of the way things are done. The first month's start in academics is important. A good start is good for morale and confidence, and usually spells success, or certainly argues well for the future. Athletics may be indulged in without detriment to class standing but if class standing is impaired to the danger point everything should be sacrificed for study.

A good football season, the Army game, Christmas leave, all come quickly. Then the mid-year examinations and a fine spring in Annapolis, with plenty of spring sports, tennis, sailing, golf, and week-end liberties in quaint and quiet old Annapolis. Then comes the end of the school year late in May, June week with its social festivities, graduation of the first class, and no more plebe year. The June ball and then embarkation on the battleships *Arkansas* and *Wyoming* for the practice cruise to foreign ports, are followed by a month's leave at home.

Returning from leave, the youngster year starts. A big rise in position—no more plebe year, no more plebe rates, no sharp cutting of corners or sitting on the edge of chairs and many other humiliating customs that the plebe is supposed to carry out. Studies become harder but the youngster now knows the system and is more experienced in naval life. Another football season, holidays, and the spring season. Another June week and graduation, but this summer no cruise. The new second classmen remain at the Academy all summer and concentrate on aviation: ground aviation, radio, navigation, and gunnery. A squadron of seaplanes is available and much flying instruction is given; then September leave, and back as a dignified second classman, going more into the professional subjects that give the groundwork for the naval officer. A year of hard academic effort, a year in which the life at the Academy is beginning to pay dividends. Physical development has probably come along now so that the midshipman second classman may be a member of a varsity team in some athletic sport. Every midshipman from plebe year on has to participate in some form of organized sport. Strength tests and swimming tests come each year with new standards and intensive work to overcome any deficiencies.

Another June week and graduation and now to the exalted position of first classman—the cock of the walk and lord of all. A fine cruise, taking junior officer's duty on the bridge, quarterdeck, and engine rooms; much navigation and gunnery, signals, and practical gun drills with the big guns. An interesting and highly instructive cruise planned to fit the midshipman for his regular duties at sea after graduation. After returning from the cruise, comes first class leave, a bully leave, then a return for the final year: cadet officers, high rank, and senior class—a fine year—enjoying many privileges and each day bringing him nearer to graduation. Final exams, no more rivers to cross, June week, graduation, and Auld Lang Syne. The paymaster has deducted enough each month to have about 800 dollars available at graduation. If commissioned, this amount is sufficient to buy the uniforms and equipment necessary to go to sea as a commissioned officer in the Navy. If he elects not to follow the Navy or is not commissioned, he has this much in his pocket as a nest egg when he leaves the Academy with a good education and a sound and trained body. Henceforth it is very probable that all classes graduating will be given commissions either in the line of the Navy, Marine, or Supply Corps; and while the entering midshipmen signs to serve at the pleasure of the President, it is customary to accept resignations when submitted. This is now a fairly well established custom.

TO sum up, the young American has had four splendid years of college training, two magnificent summer cruises in big ships to attractive ports overseas, one summer of practical aviation training, all expenses paid in school, books, clothing, food, laundry, hospitalization; spending money on leave; athletic equipment furnished—in fact, he has had no expenses whatever for four years and graduates with a savings account estimated at about 800 dollars. Where can the American boy find another such attractive proposition?

On the whole, the Naval Academy accomplishes more in four years than any other college in the country. Many great educators have, after a cursory glance at the system of the Naval Academy, suggested radical changes. In most cases it can be shown that these changes have been tried in the past and found undesirable, but it is encouraging to realize that the Naval Academy does not stand still, that it is willing to take up new suggestions to keep abreast of the times. It is this spirit which will make its work effective in the years to come, and will progress with the times.

The Naval Academy requires for graduation 130 semester hours of credit for recitations attended during the four academic years. This does not include the amount of time devoted to drills and practical instructions. It is also exclusive of the six months spent at sea—

three months of each of two summers—in the practice cruises. The courses of study are distributed among nine different departments, namely: Seamanship and navigation; ordnance and gunnery; engineering; mathematics; chemistry, physics and electricity; English and history; languages; economics and government; and hygiene. Of these various subjects, 37.2 percent are considered to be purely professional; 31.2 percent relate to mathematics and the sciences, pure and applied; while the remaining 31.5 percent belong to the so-called cultural studies.

The Naval Academy, as these proportions indicate, has a policy, similar to that of other purely engineering colleges which have followed the recent trend, to stress the fundamentals in the sciences in an effort to lay down correct educational foundations even if the specialties, wherein there is constant change in facts and in their applications, are not so fully covered. This policy makes it possible to introduce into the curriculum more cultural subjects, and thus afford a broader education for the midshipmen. A good general education has been given, including travel, practical instructions, and specialization in professional subjects that are an asset in any walk of life; discipline has been instilled; leadership taught; ability to carry out orders and, likewise, initiative have been developed.

At the time our Navy was created in 1777, John Paul Jones expressed to the Marine Board some of his ideas on the professional attainments of a naval officer. The following paragraph from this letter is posted in the front of the English book of each 4th classman: "None other than a gentleman, as well as a seaman both in theory and practice, is qualified to support the character of a commissioned officer in the Navy; nor is any man fit to command a ship of war who is not also capable of communicating his ideas on paper in language that becomes his rank."

The end sought by this training and discipline may be expressed as follows: "The doctrine is responsibility, and the problem is the formation of character." The Naval Academy spends much time in the formation of character and at an all-important period in the life of every man.

The midshipman is probably cared for better than if he had remained at home. The quarters are light and airy and kept in an immaculate condition. When the temperature falls to a certain level, heavy clothing is prescribed, overshoes and rain clothes are worn in wet weather. Regular sleep and regular hours can not be avoided. The food is the best, well prepared, and the menu selected with care. A physical examination is held once a year. Teeth examined every six months. Sick call held twice daily. An infirmary in quarters for slight ailments and a fully equipped naval hospital with an efficient staff. Care of clothes and person inspected several times daily. Religious life given every opportunity: prayers at breakfast and church on Sunday. Ample time is provided for recreation, sports, reading, movies, sailing, and dancing. Home training and social etiquette are stressed. Public speaking and after-dinner speaking are taught in the English course, and every advantage is given for social attainment.

Particular care is given to physical welfare. Many boys who passed the physical examination as being physically sound show many defects in physique. This is found out by strength tests and a carefully planned system of measurements soon after entrance. The midshipman is photographed in the nude and with a chart as a background to show front, side, and rear views that reveal faulty posture, spinal curvature, length of arms and legs, and general set-up. The corrective measures for all physical faults are prescribed and extra work with experienced instructors put on these faults.

Athletic development is stressed at the Naval Academy. Athletics for all is the motto of the Athletic Department. Coaches, instructors, equipment, and playing fields are provided for all. Teams are maintained in 19 varsity sports for competition with outside institutions.

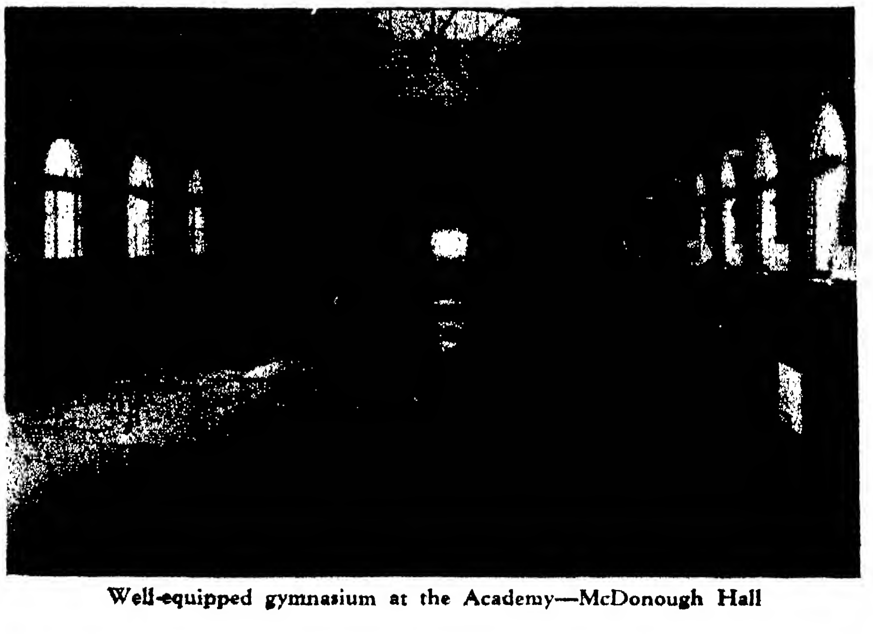
Plebe teams are maintained in all of these sports except small bore rifle and bowling. In addition, class and company teams are maintained in most all sports which gives an outlet to the midshipmen of any size or any degree of ability. Not only does this encourage all the good derived from healthy competitive sport but it develops initiative, leadership, and coaches who will in the future handle athletics not only at the Academy but will be trained to coach enlisted men in all forms of sport.

This mammoth athletic plant is financed by the Navy Athletic Association which derives its funds from its membership and games played, principally football, where admission is charged. It is doubted whether any school in the country gets the 100 percent participation in sports that the Naval Academy demands.

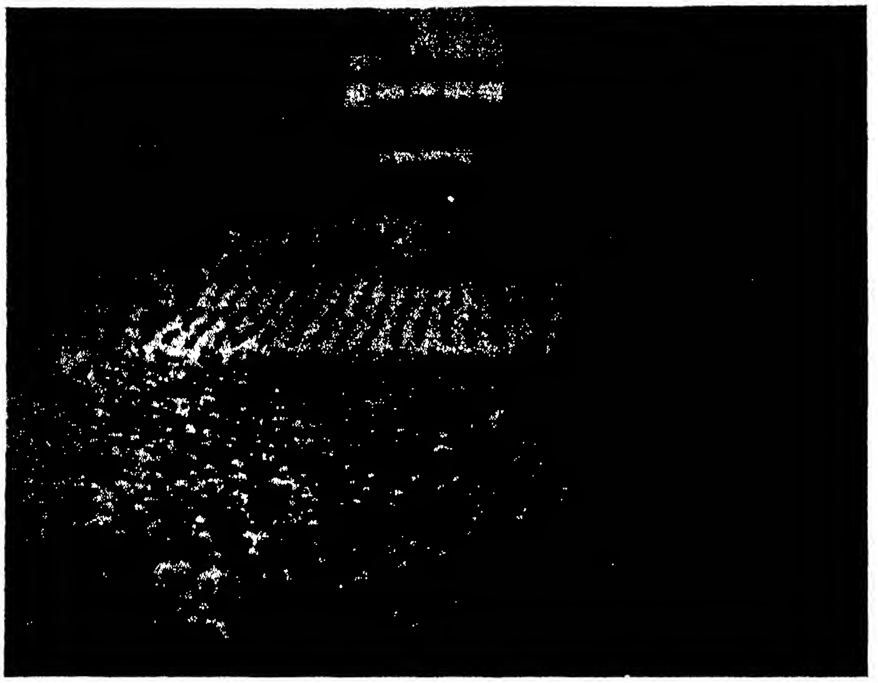
A MIDSHIPMAN'S day, strange as it may seem, begins about 45 minutes before he "turns out" in the morning. This paradox is explained by the fact that the watch squad is "turned out" 45 minutes before reveille. This squad is called by the various masters-at-arms (civilians employed as building watchmen). At 6:20 A.M. the watch squad assumes its duties, and seven minutes later the reveille breaks with bugle and gong, the latter ringing for 30 seconds. Five seconds of silence follows, and then the bell rings again for five seconds. At the second bell, the inspection is begun. All doors are opened, and an occupant of each room stations himself in the doorway and reports "All out, sir" to the reveille inspector as the latter double-times by. The "All out" means that the occupants of the room are "turned out" and that the bedclothes and mattresses are turned back in the prescribed manner.

Twenty-five minutes are allowed after reveille for the morning shower, shaving, and dressing. Then at 6.55 A.M. the call to formation for breakfast is sounded. The midshipmen thereupon fall in by companies on outside or inside parades, according to weather conditions. During breakfast formation, the daily report of the conduct (delinquencies) of midshipmen for each battalion is published by the battalion adjutant.

The battalions then march off by com-



Well-equipped gymnasium at the Academy—McDonough Hall



"Graduation, Auld Lang Syne," and a commission in the Navy

panies and enter the mess hall from four different directions. This great hall is furnished with long narrow tables, at each of which 21 midshipmen are assigned seats. There are about 90 tables, each of which has two Negro or Philippino mess attendants to wait on it. When breakfast is finished, the regimental commander rises and gives the order for the Regiment to "Rise." Then, except on Sunday mornings, he gives the command, "Parade Rest." Morning prayers are then read by the Chaplain. Then follow "Attention!" and "March out."

AFTER breakfast, the midshipmen go to their rooms to sweep, dust, and clean them in general, and to make up their beds. At 8:00 A.M. the march to the class rooms starts. During the week —Monday through Friday—the academic day is divided into five periods of approximately one hour each. The forenoon is divided into four periods, two for study and two for recitations.

At 12:40 P.M. comes lunch formation, at which the adjutant publishes various orders that are later posted on the bulletin boards. After this, the Regiment marches into the mess hall.

Lunch is followed at 1:30 P.M. by the fifth recitation period. The next event is drill, which lasts from 2:49 P.M. until 4:00 or 4:30 P.M. Each midshipman has two "long" drills per week. On Wednesdays, all battalions have the same thing—a drill period assigned to the Executive Department. A dress parade is usually held, if weather permits.

During all of the day until drill, the midshipmen wear "blue service" uniforms. These consist of cuffless trousers of dark blue serge, and a double-breasted, brass-buttoned coat to match. On each lapel of the coat is a gold anchor. On the sleeves of the coat are the marks that distinguish the classes except that the fourth class have no insignia at all. For drill, the uniforms may be blue trousers, leggings, and dark blue flannel shirt, or white "works" (white jumper and trousers), with black or gymnasium shoes.

The interval between 4:00 or 4:30 P.M. and dinner formation at 6:40 P.M. is the time for midshipmen's recreation. A great majority of the midshipmen use this period for athletic exercise of some sort. Others at this time make use of the library, or devote the period to some activity such as the "Lucky Bag" (year book), "Log" (weekly publication), or Masqueraders (amateur theatricals).

On Saturdays, only the first two periods are given to recitations, the third and fourth being devoted to drill. After that, according to the weather, there is either a personal inspection outside or a room inspection.

On Saturday afternoons, all midshipmen, except those having extra duty to perform, are given liberty to visit the city of Annapolis. Saturday evenings are given over to entertainments—hops, motion pictures, and the Masqueraders and Musical Clubs' shows.

On Sunday and holidays, the day begins at 7:15 A.M. On holidays, liberty begins immediately after breakfast. On Sundays, however, the midshipmen must go to church, either at the Naval Academy Chapel or a church of their faith in Annapolis. The uniform for chapel, out-of-town church parties, and Sunday dinner formation is full dress.

A midshipman's day is well occupied during the academic year. He "turns out" at 6:30 A.M. and, aside from the recreation period in the afternoon, the routine carries him up until taps at 10:00 P.M., when the tired middie welcomes rest and sleep.

It takes four years of such a life to prepare the graduate for his duties afloat in the Navy, and once again I quote from John Paul Jones on the attainment of a Naval officer:

"He should be the soul of tact, patience, justice, firmness, and charity. No meritorious act of a subordinate should escape his attention or be left to pass without its reward, if even the reward be only one word of approval. Conversely, he should not be blind to a single fault in any subordinate, though, at the same time he should be quick to distinguish error from malice, thoughtlessness from incompetency, and well meant shortcoming from heedless or stupid blunder. As he should be universal and impartial in his rewards and approval of merit, so should he be judicial and unbending in his punishment or reproof of misconduct."

THE growing boy has many ideas for his future—where he would prefer to go to school and what business or profession he would choose. Then again, he has ideas of adventure, travel, and romance. Many boys have their lives carefully mapped out for them: prep school, college, then on down the groove prepared by Father. Others enter high school with no plans for the future. Yet it is safe to say that the younger generation of today, by the time they have attained high school age, are taking into consideration their future, both as to schooling and occupation, maybe not in a methodical manner but certainly with an eye to grasping the best opportunity presenting itself. They seek independence, contacts, and lucrative positions. Many are doomed to disappointment and drift along with the tide of humanity that simply exists but does not get anywhere in particular.

The writer has been a discipline officer, instructor, coach, and head of a department at the Naval Academy and over a period of 30 years has had the opportunity at first hand to observe the many opportunities extended to the American boy so fortunate as to enter. At the same time I have observed and compared what outside institutions have had to offer. My conclusion has been that many boys scattered over this broad land did not know much about the Academy, its life, and the future it offers.

If I have made the picture clear and extolled the opportunities offered I have done something for American youth and at the same time made more and better material available for the officer personnel of our first line of national defense.

Radio in Naval Tactics

By LIEUT. W. B. AMMON, U. S. N.

THE underlying principles of naval tactics are as fixed and unchanging as the theorems of geometry. However, as the type and style of weapons change and technical improvements are made in ship equipment, the application of the principles is varied.

The battle organization of the Fleet is similar to the structure of an athletic team with the Commander-in-Chief as the team's captain. The subordinate unit commanders and ship captains must know not only the doctrines and plan for battle, but the manner of carrying it out so that the Fleet may be a coordinated and effective weapon.

Radio permits the far-flung scouts to give vital information instantaneously to the Commander-in-Chief and his subordinate commanders, whether the scouts be submerged submarines, swift cruisers and destroyers, or speeding aircraft. It facilitates carrying out the principles underlying the dissemination of information. It is the means by which the Commander-in-Chief may disclose his plan simultaneously to a hundred or more scattered but alert ears just before meeting the foe. Hence, he is better able to take advantage of the tactical element of surprise. During action, radio is the invisible means of putting the heavy guns on distant targets. It is the agency used to give information of damage inflicted on the enemy to the team captain and the instrument to enable him to harmonize the actions of his forces and direct their efforts so each contributes the maximum effectiveness to the whole.

Technical advances in radio since the World War facilitate the maneuvering of the Fleet as a unit under its Commander-in-Chief. Radio serves as the Fleet's voice and ears, making communications as vital to the Navy as gunnery, engineering, and damage control.

The major advance is considered to have been the perfection of the vacuum tube. Some of the earliest types of tubes had a life of about 70 hours and cost approximately 50 dollars each. Today the life is measured in thousands of hours and the cost is only a few dollars. Vacuum tube development made available many types of compact transmitter and receiver circuits which were suited to installation in the confined spaces allotted in a man-of-war. The detection and amplification of signals improved greatly and resulted in longer range receivers. With progress in the technique of vacuum-tube manufacture, transmitter power and sturdiness of tubes was improved and the communication range between ships has increased from a few miles to thousands of miles. The advent of shock-proof tube mounting and the use of non-corrosive and moisture-proof materials in other parts insured equipment against damage from shock of gunfire, rough handling, and the destructive effects of sea spray and air. The evolution of the vacuum tube was the primary step toward fulfilling the Navy's demands for rugged equipment suited for long or short range transmission, simultaneous communication on many channels, and capable of either telegraph or telephone use by submarine, surface ship, airplane, or land station.

Another development increasing radio's value in naval operations was the elimination of much of the interference experienced during the World War. Frequency stability has been perfected and with it the means for rapid shifting of frequencies and accurate calibration of transmitters and receivers. Hence, without mutual interference, frequencies close to each other in the radio spectrum can be assigned within the same body of ships. The receiving operator's problem is simplified; his attention can be devoted wholly to copying a message instead of attempting to receive it while tuning his set to follow the transmitter's vagaries. More accurate receiver tuning has partially overcome static. Scientific shielding has obviated local interference, particularly in aircraft, where electrical noises from the ignition system, motors, and the like, are serious obstacles to good receiving conditions.

A third improvement was the introduction of automatic transmission and reception. Manual transmission rarely exceeds 35 or 40 words a minute even with a high-speed key or "bug," while the use of "automatics" permits speeds above 500 words a minute. Consequently, a circuit's capacity is increased tremendously and the human operator with his inherent errors is eliminated except for punching and copying the tape.

A great many technical advances in the radio art have resulted from the Navy's early and constant demands for better equipment and the tremendous growth in the popularity of radio broadcasting, beginning about 1921.

Future naval "ears and voices"—a radio operators' training school

The opinions or assertions in this article are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

A FORECAST OF WORLD

Design Trends in Naval Ships . . . Eyes Focused on Japan . . . What Ships Powers Will Build; What Types Discard . . . Possible Design Modifications

By OSCAR PARKES
Formerly Editor, "Jane's Fighting Ships."
Specially prepared wash drawings by the author

NOW that Japan has announced her intention of terminating the Washington Treaty in 1936, and Germany has renounced the limitation of the armaments under the Versailles terms, we are faced with the possibility of a return to unrestricted naval construction—unless some sort of agreement is reached next year which will place a check on global tonnage. Ten years ago, world conditions were such that limitations in the design, size, and numbers of the different types of warships permitted to be built were more or less acceptable to the Powers. Today such artificial standards are no longer in favor as experience has shown that they lead to the construction of uneconomical types of ships unsuitable to all concerned.

The present attitude of the Powers with regard to their naval requirements is far more difficult to define than it was before the World War. In those days the expansion of the German Navy clearly indicated the quarter from which trouble could be expected and the British Navy was being built expressly for the time when "Der Tag" should dawn. France expected trouble from the same quarter, and the members of the European alliances were anxiously calculating how much would be expected of them in the event of hostilities. Today a very different state of things obtains. On all sides there is a realization that economic and national aspirations in Japan, Russia, Germany, and Italy may lead to trouble sooner or later. The present peace pacts in Europe may do much to restrain nationalism, but between East and West there are rifts which time is not likely to close—territorial and commercial aspirations which already appear as dark clouds on the horizon, especially in the Mediterranean.

Today the German Navy presents no menace, although the designs of the ships provided for in the 1935 Program may be quite as provocative as was that of the *Deutschland*. The two battleships of 26,000 tons—in that program—are to be armed with 12 11-inch guns—which may be taken as indicating that the Marine Admiralty are at one with the British Admiralty in considering such displacement and gun caliber adequate for battleships, or that a big reserve of 11-inch guns has been built up for future 10,000 tonners and it has been thought advisable to get as many afloat as soon as possible, in which case the tonnage would be sufficient for a four-turreted, well-armored ship of the *Deutschland's* speed.

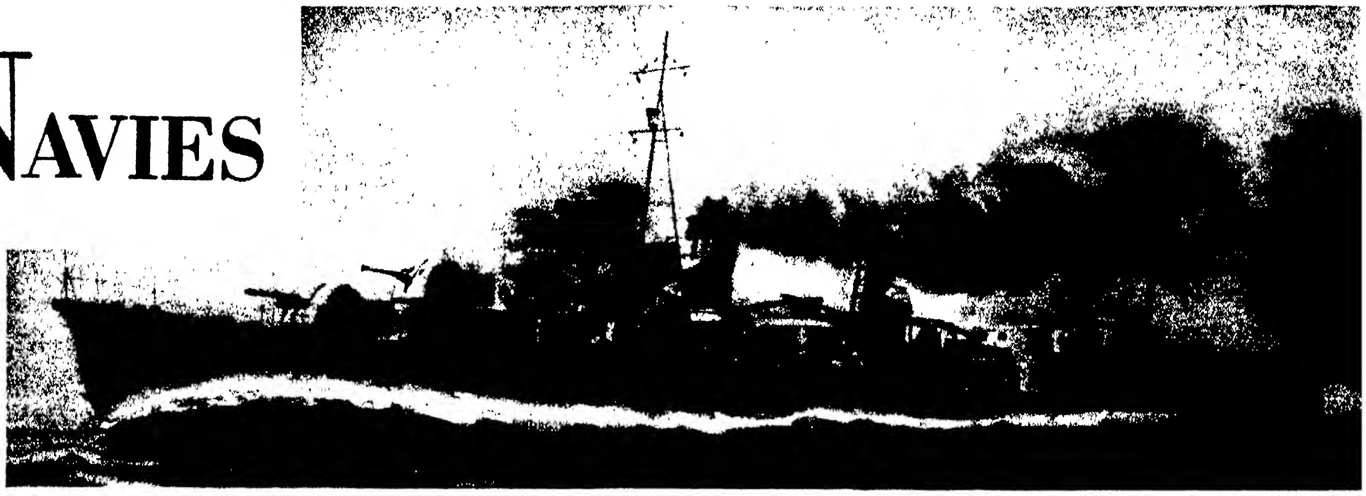
The two cruisers of 10,000 tons with 8-inch guns, on that program, will presumably be smaller editions of the same design, and not likely to be over-burdened with aircraft. Judging by the light type of catapult which has been installed in the battleships and cruisers, the air arm will be employed mainly for scouting and spotting. Bombers over the Baltic will be operated from shore bases with carriers for the wider seas work, and converted liners seem likely to be utilized for this.

IN raising their destroyer tonnage to 1625, with an armament of 5-inch guns, the Germans are taking a leaf out of the French book and, if anything is likely to make the British break away from the standard type which has served for so many years, it will be these boats. Considering that, before the War, German light cruisers carried only 4.1-inch guns it is high time that some term other than "destroyers" were chosen for these overgrown torpedo craft.

The German menace being negligible, it is on Japan that our attention is sharply focused. No longer satisfied with a 40 percent inferiority to the American and British Navies, she is determined to provide herself with whatever forces she deems necessary, and it is the additions made to her fleet which will dictate the future development in our own. And so, in discussing the possible naval developments the world over it will be as well to take Japan first—and here we are up against the dictating factor in war-

Japanese cruiser *Mogami* of 8500 tons carrying 15 6-inch guns in five triple turrets—three forward, two aft. Her two stacks merge into one; mass of bridgework slightly reduced compared with previous designs. Eight 5-inch anti-aircraft guns in pairs are amidships; the catapults are just forward of number four turret. She makes a speed of 33 knots with 90,000 horsepower

NAVIES



Japanese destroyer *Nenohi* of 1378 tons armed with five 5-inch guns in twin turrets fore and aft and one single raised turret. Originally intended for nine tubes, she now mounts six only in two triple mounts. These have shields and can be seen between the funnels and abaft the second funnel. Her speed is 34 knots with 37,000 horsepower. Later vessels will have eight tubes in quadruple mounts. Note the piled-up bridge and the way the torpedo shields are placed on raised mounts instead of on deck

ship design which bristles with difficulties. Well served by a corps of constructors who have studied in most of the naval schools in Europe, it is not surprising that a very remarkable degree of purposeful originality has been brought to bear upon the design of all types of warships. Ton for ton, Japanese designs show a greater all-round value than those of any other country—to a large extent because they are not hampered by the standards of habitability which obtain, say, in ships of the United States and Britain. As one distinguished Japanese staff officer recently reminded me in discussing the features of their ships "Remember, please, that we have to make up for the 40 percent"—meaning that their ships are designed to embody an individual superiority over their "opposite numbers" in other navies sufficient to neutralize the 5 to 3 ratio of the Washington Treaty. To a large extent this is possible because of their personnel. A six-foot deck is ample for the national stature, and accommodation suitable for their standard of living can be provided without the sacrifice of space considered necessary in our ships. Thus by lowering freeboard and reducing draught, and packing their hulls with turret bases, engine and boiler rooms, and torpedo flats, their designers manage to provide more fighting qualities in a ton of displacement than ever we can.

And as their hulls cannot contain cabins and stations which in our ships would be below decks, they have been incorporated in great pagoda-like structures which are replacing the heavy foremast in Japanese ships, around which are hung rangefinders, director towers and searchlights like plums on a tree. Granted that this vast structure may be a wonderful target, it also has the virtue of being exceedingly rigid and free from vibration, which is a very vital advantage in a lightly built and highly powered ship such as they build.

In the past, Japan has leaned towards the monster battleship and is likely to continue to do so. But the claims of the armored cruiser of the *Deutschland* type appeal vastly to the Japanese, judging by my correspondence. Such ships would be ideal wide-radius commerce raiders and their very threat would strain convoy protection to the limits. As soon as the Treaty terminates we may very well expect Japan to try out the *Deutschland* idea along her own lines and produce, say, a "six 12-inch gunned," armored ship with high speed and adequate protection against such ships as she might choose to engage. In the past, Japan has aimed at initiative in the matter of warship types—the *Tsukuba* and *Kurama* classes of pre-war days would have settled the hash of any armored cruisers—and it must not be forgotten that she introduced the 8-inch gunned cruiser in her *Kako* and thus forced the other Powers to go in for this unwanted type in which she has always maintained the lead.

AT present she is committed to 6-inch guns in her cruisers, and in the *Mogami* class she has certainly produced wonderful ships upon the 8600 tons credited to them. (In a letter to us from Dr. Parkes, after he had forwarded the article, he says: "By the way, you may be interested to know that the *Mogami* came down badly on trials. The high speed and firing of 15 6-inch guns so strained her welded hull that she filled her oil tanks from the sea and finished up drifting about off Kobe. She is the first big welded ship and the Japanese have not been very fortunate in that branch yet." It seems that the Japanese have not mastered the technique of welding, but their work will certainly bear watching.—*Ed.*) The attitude of the Japanese to the 6-inch gun nowadays is difficult to define. Formerly, when such guns were hand-served, they were unpopular as the 100-pound projectiles were too heavy for her personnel to handle and she found the 5.5-inch quite large enough. Now that power-operated 6-inch guns with anti-aircraft mountings have come along, this caliber may be more appreciated but it is an open question whether five sets of triple-mounted 6-inch guns, as in the *Mogami*, would be viewed with as much favor as would the equivalent in 7-inch or 8-inch guns when the Treaty restrictions come to an end.

As regards aircraft carriers, very little is known about the *Soryu*, of 10,000 tons, now building, but I am told that she will be a cross between the *Akagi* and the *Ryujo*—and as likely as not turn out to be something in the way of a cruiser-carrier, with 6-inch guns, instead of 8-inch as in *Akagi*. Such a ship would have to sacrifice a certain amount of carrying capacity in favor of an increased armament and be regarded as an alighting platform for the 'planes of her consorts. There is much to be said for such a type until such time as the autogiro obviates the necessity for an alighting deck.

Developed along Japanese lines, the destroyer has become a miniature cruiser with her guns and torpedo tubes protected by shields, and an extraordinary amount of top hamper. Since the capsizing of the *Tomodzuru*, her torpedo craft have been rather under a cloud and the commission which investigated recent designs called for modifications in the types now building, but the extent and nature of these are not known. The mounting of the tubes on platforms instead of on deck adds greatly to topweight which, in addition to their heavy bridges, must considerably reduce their margin of safety even if it does tend to reduce rolling. British destroyers are said to be able to stand an impossible inclination without cap-

British cruiser *Southampton* of 9000 tons, carrying twelve 6-inch guns in four triple turrets, will steam at 32.5 knots. She has eight tubes and four 4-inch anti-aircraft guns, and is the best the British can do under Treaty tonnage limitations as a reply to the Japanese *Mogami*. Note the absence of top hamper, the two funnels which are pear-shaped in section, and the catapult between the funnels

sizing, but are lively in consequence; the Japanese seem to be aiming at a "stiffer" but more unstable type. According to recent reports the *Ariake* class now carry only six tubes instead of nine and illustrations show her with only two sets of triple tubes.

When the Treaty terminates, it is more than likely that future destroyers will be enlarged into small cruisers in the same way that the French propose. The original metier of "torpedo boat destroyer" has long since passed with the old-fashioned torpedo boat, and there is no reason why they should not develop into sea-going ships and replace the old "third-class cruiser."

Within recent years, Japan has been experimenting with a variety of small craft which add considerably to her strength although claiming little attention. Her fleet of 400- to 600-ton mine-layers, net-layers, mine-sweepers, and chasers are very efficient little ships and show that she is fully alive to the value of these ancillary craft of specific but interchangeable rôles. None of them is built for "police duties" in peace time with a limited war value for their displacement—as is the case of the British sloops—but of course they have a restricted radius of action and will operate only in home waters.

At the present moment the whole battle fleet is scheduled for drastic reconstruction and the *Fuso* and *Yamashiro* have already undergone modification which have changed them into one-funnel ships with increased protection, catapults, additional anti-aircraft guns, etc. From all accounts, the *Nagato* and *Mutsu* will be also considerably changed; at present both are stripped down with their turrets taken out, the former at Kure and the latter at Yokosuka. *Nagato* will be the first completed and her advent in new guise is awaited with the greatest interest. I understand that she may emerge rather like the *Mississippi* with one funnel and a tower mast forward. That her 16-inch guns will have increased elevation goes without saying, also that her anti-aircraft armament will include 5-inch guns in shields as have been fitted to the *Ise* and *Hyuga*.

Nothing is known about the 5000-ton mine-layer *Okinoshima*, now building at the Harima Works, and it will be interesting to see whether the mine cargo will suffer at the expense of armament—my own view being that she will be a fast layer with a good anti-aircraft battery only. If this should be the case, her mine capacity will be very large—over 500 large-type at least. She will be designed for overseas operations like the British *Adventure* but with a higher speed. I understand.

So much for the anticipated lines of development in the Japanese Navy, and it is upon these that other Admiralties will base their naval programs. So far no vessels of a novel type have been laid down in Japan, and to a great extent future competition will depend upon whether or not this policy is maintained. It is the advent of something new in warships which leads to fresh outbreaks of competition—as was the case with the *Dreadnought*—and it is the departure from conventional type which will most disturb Washington and London.

If Japan brings out a battle-cruiser on *Deutschland* lines, then America will have to revise her shipbuilding program; if not, no radical departure from the classes now building may be expected for some time. Reconstruction of the *California* and *Colorado* classes has been postponed and it is not likely that they will be taken in hand until after 1936 when new capital ships will be laid down. The design of these opens a tremendous field for conjecture, but it may be accepted that their displacement will not be below that of the new ships recently laid down in France and Italy and in all probability will exceed 40,000 tons. Upon this displacement they could carry twelve 16-inch guns and steam 23 knots, with the guns either in four triple or three quadruple turrets, and a heavy dual-purpose secondary battery which would probably be mounted in small multiple turrets. At present, anti-aircraft guns in American ships are on open mounts but there is much to be said for the French and Japanese method of protecting their crews from aircraft fire. As visualization of such a ship, I should be inclined to suggest a type carrying three quadruple turrets, two forward and one aft—American constructors do not particularly favor the massing of all the main armament up forward as in the *Nelson*—the multiple dual-purpose, 5-inch guns would be in turrets along the topsides and amidships aft, and no torpedo armament. If the War proved anything, it proved the waste of weight and space in fitting torpedo tubes in battleships.

The American *Savannah* promises to be a very serviceable type of cruiser with her 15 6-inch guns and is likely to be in favor for some time to come. In addition, some sort of flight-deck cruiser will probably be tried out, but the possibilities in the autogiro, when naval types with high power and carrying capacity are built, may obviate a special vessel for alighting purposes. Indeed, this ability to arise and alight on a confined space would seem to presage the end of the catapult which now

French battleship *Dunkerque* of 26,500 tons, carrying eight 13.2-inch guns in quadruple turrets. Her secondary armament of 16 5.2-inch guns is in quadruple and twin turrets and the catapult is on the quarter deck. She is said to carry 10,000 tons of armor. Note grouping of the three quadruple anti-aircraft turrets aft. Her speed is 29.5 knots with 100,000 horsepower

makes such a call on deck space and weight. At present the only hybrid of this sort is the Swedish *Gotland*, which is a carrier with a cruiser armament, but her 'plane deck is for stowage only and not for alighting. So far as I can gather, the American flight-deck cruiser would serve more as an alighting ship than as a 'plane transport, and such a vessel might be built under the Treaty without delay, if its exact rôle could be economically assured. I say "economically" because the autogiro introduces a new factor when the provision of ships of this type has to be decided upon, and it would be a waste of money to embark on their construction if the development of aircraft made them unnecessary.

For the same reason, it looks as though the giant carrier would have no place in future programs. Twenty thousand tons displacement is big enough for anything in the way of a carrier pure and simple—if not almost too big. Such ships are too vulnerable and their cargoes too precious to risk the concentration of 50 or so 'planes in one hull, and most admirals would be happier to know that their air force was divided into two smaller hulls. The battleship-carrier which was mooted some years ago is an absurdity which will never materialize, and ranks with the submarine carrying big guns such as was tried out for the British Navy in the unfortunate "M" class. Both Japan and America will build large submarines, but practical experience has shown that the British *X.1* and French *Surcouf* types are not a good investment. Already *X.1* has finished her career and is on the suspension list, and the French have never gone any further with the proposed sister to *Surcouf*.

In smaller craft, America is going to the limits, as regards displacement and gun powder, in her *Erie* class, which are reported as being 2000-tonners with four 6-inch guns. If such an armament can be properly fought from a hull of this size, then the design will find favor everywhere. For convoy work, they should prove of all-round value as they carry a hangar and 'plane, and four 6-inch guns will have a word to say to any raiding cruiser. I shall have something to say about such sloops when discussing British ships so will pass on to the possible developments on the other side of the Atlantic now.

Although Herr Hitler has not outlined any features of the new navy he intends to build, his recently consummated naval treaty with Britain has taken the uncertainty out of the Anglo-German naval problem. This menace removed, Britain is faced with the problem of the rapid expansion in the Far East. (And, at the moment, the alarming Mediterranean situation.—*Ed.*) Now, the British Admiralty are no great advocates of large dimensions—they would willingly see battleships restricted to 25,000 tons and 12-inch guns, and cruisers to 7000 tons and 6-inch guns. The reason for this, of course, is that numbers are imperative because so many overseas squadrons have to be maintained and the possession of adequate fleet bases all over the world greatly lessens the fuel provision problem; without bases, ships must carry a vast fuel supply if they are to fight overseas and this means an all-round increase in size. With France and Italy both constructing huge battleships it is hard to see how England can rest content with 25,000-tonners when the opportunity of building them again comes along—public opinion would demand ships equal to those abroad even if the Admiralty had the courage of their convictions—and a reversion to the practice of former days, when first- and second-class battleships were built, would seem to be the possible solution.

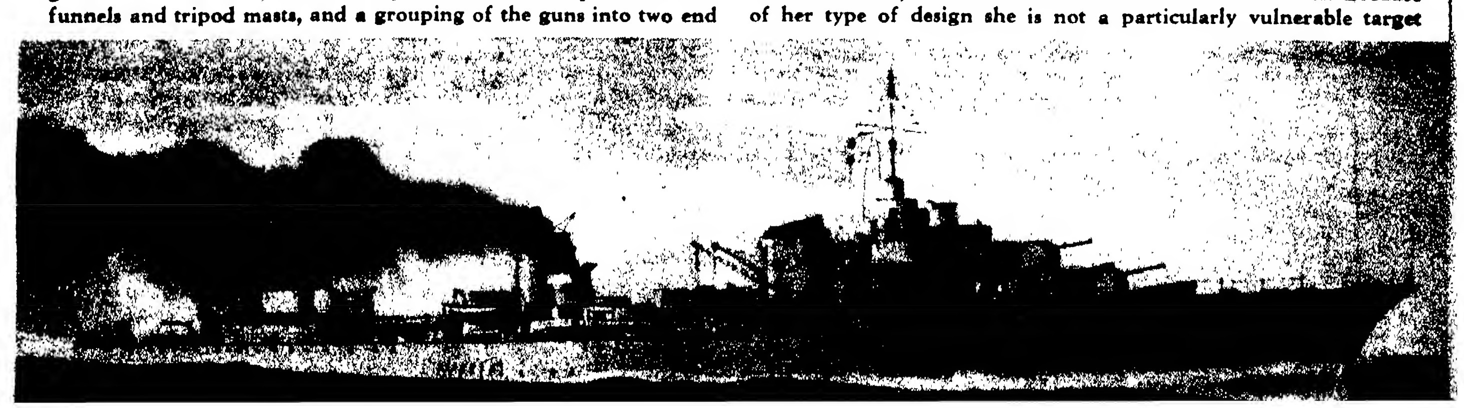
A 40,000-tonner would be pervious to fire from 13.5-inch guns, and a ship half her size carrying six of these, with high speed and thick armor, would be no mean antagonist when built in the ratio of two to one. The same line of argument applies to cruisers. Although the *Arethusa* class, with six 6-inch guns only, is not going to be popular in the Service because of her obvious inferiority to every other ship of her class afloat, yet when numbers are essential and accident or mishap can put a ship of twice her size out of action just as easily, there is much to be said for the minimum of effectiveness.

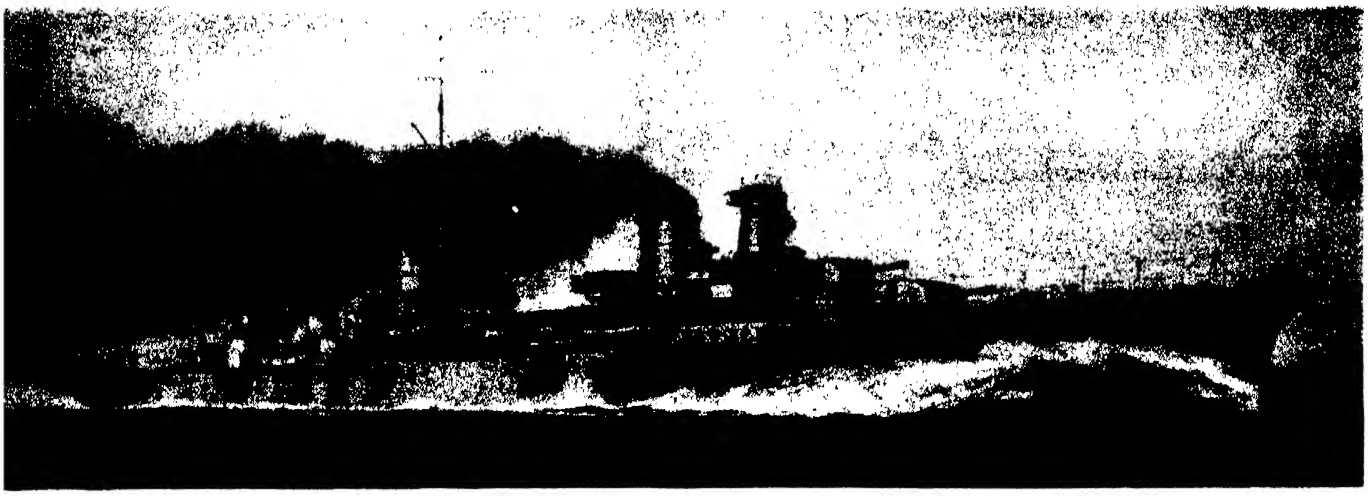
Faced with North Sea and Pacific problems, the solution will probably lie in building a variety of types large and small, of which the smaller units would be assigned to home service. For the protection of her sea trade, England requires cruisers in excess of anything she is ever likely to build, but as convoys may be attacked by every class of warship from battle-cruiser to submarine, and adequate protection cannot be provided to meet every emergency, a compromise must be evolved in the convoy cruiser. As nothing less than 5000 tons would make for steady shooting on the high seas, it seems unlikely that the *Arethusa* will be much improved upon excepting so far as her shortcomings in service may indicate.

No departures from conventional type need be expected in the British Navy. There is no Fisher spirit at the Admiralty and it is realized that the introduction of a new type of ship only nullifies existing superiority and leads to fresh competitive building.

France having renewed battleship construction with the *Dunkerque*, Italy has responded with still larger ships and so set the pace for future com-

French "leader" *Fantasque* of 2569 tons, carrying five 5.5-inch guns and nine tubes, shows a departure from the previous four funnels and tripod masts, and a grouping of the guns into two end sections. With 74,000 horsepower, she was designed for 37 knots but has actually made 42 knots under service conditions. Because of her type of design she is not a particularly vulnerable target





Italian cruiser *Montecuccoli* of 5857 tons, armed with eight 6-inch guns and steaming 37 knots with 110,000 horsepower. She is lightly built and has no armor. The catapult is amidships with stowage for three planes. As an enemy target she has been very much reduced and the former tripod mast and tier of bridges forward have been replaced by a simple turret-like tower

petition. The French favor the quadruple turret which is practically two twin turrets on a single base, the pairs of guns being divided by a thick screen. There is considerable saving in weight, thus allowing for thicker armor over the turret and magazines; and control is simplified. The lay-out of the *Dunkerque* can be seen from the illustration —as in the *Nelson*, there is no stern fire, and it is reported that in the *France* (her third new battleship) there will be three quadruple turrets, one forward and two astern. There is much to be said for tactics which are based on the leading position in an action—call it fighting on the retreat. Gunfire astern leads to better shooting, and the ahead position in battle confers the initiative in smoke screening, torpedo attack, mine dropping, etc. Whatever constructional advantages turret concentration forward may confer, the tactical disadvantages (and especially blast effect on firing abaft the beam) cancel these out. Incidentally, the official model of the *Dunkerque* shows one turret at each end, so the decision to place both forward was a last minute one, influenced by the British practice.

France is building six cruisers of the *La Galissonnière* class with nine 6-inch guns in three triple turrets—two forward and one aft—which are moderately well protected against 6-inch gun fire, and has a leaning towards the quadruple turret in her subsequent ships. In addition, she has a type of large "leader" still building which carries five 5.5-inch guns and can steam over 40 knots. These are overgrown destroyers, expensive and only suitable for destroyer work. There are designs prepared for a 3000-ton vessel carrying 5.5-inch guns which would be a cruiser and fit for high-seas work and endurance. That the large destroyer will merge into the cruiser is becoming obvious on all sides—the Netherlands "leader" of 2000 tons which was designed by Yarrows to carry eight 4.7-inch has been dropped in favor of a German design much larger and more heavily armed, if finances run to her construction, and in other quarters similar ships are under consideration.

Italy is completing her last batch of very fast light cruisers armed with eight 6-inch guns and steaming over 37 knots. This type has grown from 5000 to 6800 tons; and the design, from being rather like a young dreadnought with big superstructures and tripod masts, has become modified to a very reduced target in which the foremast-bridge is now only an armored tower. We are far more likely to be surprised with something fresh in the way of designs from Italy—in the past she has produced ships like the huge *Italia* of 18 knots and carrying four 104-ton guns which appeared in the late 'eighties, the *Reine Elena* which introduced the fast battleship early this century, and Cuniberti's first suggestion for the *Dreadnought*. At present she is re-constructing her older battleships into battle-cruisers; and the *Littorio* class of 35,000 tons and 125,000 horsepower will be tremendously powerful ships of high speed and novel characteristics, from what meager information has leaked out.

To sum up, present indications are that no radical departures from conventional types will appear yet awhile. I think that the flight-deck cruiser will wait upon autogiro developments and that the *Deutschland* will set the fashion for fast battleships in most navies after 1936. Cruisers will multiply in types as national requirements demand, and destroyers will merge on the one hand into fast scouts and drop back again to more moderate tonnage like the British standard type which is big enough for fleet work and well able to hold her own. Submarines have reached a standard which does not offer much scope for improvement—increased speed means a great increase of size as in the British *Thames* type of 22½ knots—and only a few of these can be built at the present cost. Sloops are going to appear in all navies and their characteristics will vary as their duties; and much will depend upon the success of the United States *Erie* class in determining size and armament.

Meanwhile, we can be entertained by the stories of the Japanese one-man submarines, and extraordinary ships which the British are supposed to be building, descriptions of which periodically crop up in the press but which have no foundation except in the minds of the "special correspondents" who thrive on them.

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Dr. Parkes' splendid article is all the more provocative, so far as American readers are concerned, since it stresses the non-competition idea so often reiterated by Americans. "It is the advent of something new in warships which leads to fresh outbreaks in competition," he says at one point. In summing up, he says: ". . . present indications are that no departures from conventional types will appear yet awhile."

The United States will not enter any naval building competition. In fact, it seems that, even in building our Navy up to Treaty strength, we must "follow the leader" in design and development of types. This is due to our lack of experience. Rather than spread our program over a period of years, we practically stopped building anything for years, and our naval constructors have had to start almost "from scratch" in providing vessels under our new program. It is to be hoped that, in the future, the needs of our Navy will be filled through a sane, continuous building program which, while not inviting competitive building, will inspire respect for our policies and permit us to go our way in peace.—*Editor.*

INDUSTRY AND THE NAVY

Tangible, Cash Results to Industry from the Navy's Demands for Superior Products

By F. D. McHUGH

GRACIOUSLY refusing to take all the credit himself for his successful flight, solo, from New York to Paris in 1927, Colonel Lindbergh did something more than achieve a well earned fame: he called attention to the other half of the team "We." Despite his able piloting, that trip could not have succeeded if that other half, *The Spirit of St. Louis*, and more particularly its air-cooled engine, had not reached a high stage of development. The engine, too, became famous as a result of that flight. Its perfect functioning and absolute reliability called the attention of the world to the strides made by American aviation designers. That reputation has since been sustained and built up to such an extent that, now, American aviation engines find a steady market abroad. But besides assisting in opening a world market for our airplane engines, this one flight stimulated such interest in aviation that it has been possible for the United States to establish the world's greatest system of airways.

This is all history, of course, but we emphasize the facts because the Navy was directly responsible for that air-cooled engine. It was evolved directly from an engine developed for the Navy by the manufacturer's engineers in collaboration with Navy engineers. This development could not have taken place except for the very great assistance of the Navy Department since the excessive design and research costs rendered the engine prohibitive for commercial development, and the Army was not in the market for this type.

Thus we have a key to the situation that has obtained in many industries. Radio, for example, owes much to the Navy, for the Navy was the first large organization to enter the radio telegraph field in America. The present high efficiency and low cost of radio communication equipment are largely due to the Navy's work and its demands on manufacturers for continued improvements. Here, then, is the key, as shown by the air-cooled airplane engine, by radio, and by numerous other products: These have been made available for other services which, without the Navy's assistance, would have been deprived of them.

The Navy is, indeed, a protector of American rights and policies. Yet it is something more, something vital in its influence on American industries. It is a vast marine laboratory, stimulating research and fostering scientific progress and industrial achievement. Seeking always the latest, most improved products of applied science in order to maintain its proficiency, it makes its specifications so rigid that often manufacturers must do considerable research or must re-vamp entire plants to fill the requirements. Knowledge and experience thus gained by the manufacturer has often produced a better commercial product.

STEEL is a case in point. Steel owes its beginning in America as a great industry to the demand of the Navy, in 1881, for better steel than was then available. The Diesel engine is likewise indebted to the Navy. American Diesel engines, before the World War, weren't quite up to snuff. The Navy's work in dissecting and analyzing a German Diesel engine, after the war, put the industry on the right track. Witness, now, Diesel-engined streamlined trains, buses, trucks, stationary installations, and the promise of Diesel automobiles.

When the better steel was demanded, no steel manufacturer was willing to accept the contract to deliver steel on the Navy's specifications, but finally contracts were made. Even then, due to the enormous manufacturing difficulties, pressure was brought to bear on the Navy to force modifications of the requirements. The Department, however, refused to be either coerced or cajoled: the manufacturers finally succeeded; and the net result was the birth of an American steel industry, now grown to be larger than that of any other Nation.

Not content to let its feats stand as the ultimate, the Navy demands constant improvement; and not content to sit idly by after making such demands, makes complete tests of products, suggests methods of improvement, offers the manufacturer the fullest co-operation in the necessary research or reorganization.

The American Navy was the first to develop and use the "electrical reduction gear" for ships, electrical drive being first used in our battleships built during the World War. Since then electrical drive has been found most satisfactory for large liners. The bulbous bow which is now used on many of the large liners (the *Bremen* and *Europa*, for example) with great savings in fuel, is another Navy development. Its principle was discovered by Rear Admiral Taylor in researches in the model testing basin at Washington. The process of welding ship hulls, which holds such promise for commercial ships, is still another application in which the Navy pioneered.

The welding of boiler drums has progressed, under the prodding of the Navy's demands, to the point where one manufacturer (at least) can produce welds equal to, or better than, the plate metal in tensile strength, ductility, impact resistance, grain structure, and ability to withstand repeated stresses.

Some other outstanding developments of far-reaching importance, commercially, brought out or inspired by the Navy are: "slow-motion" movies, developed in collaboration with the Edison Laboratories in 1913; aluminum foil heat insulation; American optical glass for scientific instruments, telescopes, and the like; duralumin for construction of pontoons for flying boats—but, enough of detail.

On page 231, Captain Jonas H. Ingram has given detail enough of Navy progress during the past 15 years. It is a notable fact that most of the developments of which he writes have tremendous significance outside the Navy; some may, in fact, revolutionize their producing industries to the ultimate advantage and profit of civilian users. What Captain Ingram modestly refrained from telling is that only the Navy's actual work, its advice, or suggestions, or a combination of all three made these developments possible. And industry has profited tremendously thereby. It can, therefore, be said without fear of contradiction that the Navy's scientific work has returned more than enough *cash* dividends to the American people to pay back the annual appropriations made to it by Congress for many years!

FLYING IN THE NAVY

Determining Factor in Tactics . . . A Combatant Arm of the Service . . . Three General Classes of Aircraft . . . Will Battleships Become Obsolete?

By CAPTAIN P. N. L. BELLINGER, U. S. N.

SO long as there is ocean-borne commerce and so long as there are wars between nations, there will always be naval battles, although a major fleet engagement may never again be fought. Some contend that the potentialities of aircraft have offset the effectiveness of such an array of floating fortresses, or that future fleet engagements will take the form of raids. Perhaps it also may be argued that a fleet "in being" is more potent than a fleet in jeopardy. Nevertheless, so long as there are ships on the seas, whether they be merchantmen or combatant vessels, we can expect ships to engage in sea battles in some form or another. Where these engagements will take place will depend largely on the effectiveness of aircraft.

Prior to the advent of aircraft, ships during a state of war could move about on the high seas with ships of the enemy as their only opposition. Now, however, their movements are not only curtailed by enemy ships, but also by the airplanes carried on these ships and by airplanes from shore bases as well. How far away from their shore bases these planes can be effective will be a determining factor in the location of an operation, its type, and the tactics employed.

The modern navy, and the United States Navy rates itself as such, must now have its aircraft as an integral part of its force. All of the capabilities and endeavors of naval aviation further naval interests and are designed to fit the Navy to perform its functions better. In naval aviation, the reliance of ships upon aircraft and aircraft upon ships, the co-operation required between these two fundamentals of the Navy, the necessity for co-ordination of their employment through one high command, the sameness of their objective, require that naval aviation, as it is conceived today and as it may be expanded tomorrow, be an integral part of the Navy.

Little did we realize in the early days that aviation would ever play this important part. It was no doubt with the idea of delving into the mysteries of the unknown that in December, 1910, the Navy Department ordered one officer to the Curtiss Flying School for instruction. By the end of 1912 there were exactly seven men in the Navy who knew how to fly, and even in 1917 and later, there were many who had so little faith in the usefulness of naval aviation that they considered that an officer jeopardized his future in the service by continuing in aviation. As the years have gone by and the airplane has developed, its importance in the Navy has steadily grown until now no war plans are considered without due regard to the employment and effect of aircraft.

The old idea was that the only use for planes was to serve the ships on which they were based. Their job was to scout and to spot for gun fire. Aviation was called "The Eyes of the Fleet"; correctly called, too, for at that time it was not capable of playing more than an auxiliary part. But in spite of all this, there were a few individuals with sufficient vision to look forward to the day when aviation would be a potential factor in the Navy.

A study in contrasts: *Above:* The Navy Aircraft Section at Vera Cruz in 1914. *Right:* A flight of modern carrier-based airplanes on maneuvers over Midway Islands

It was not until after the World War that definite steps were taken to put aviation into the Fleet. There had been experimental development aboard two ships prior to 1917 but, due to the stress of war, this work had been discontinued. In 1919, however, a policy was established to put one or more planes on each and every combatant ship capable of carrying them. During the period of execution of the project, all available funds were used for that purpose, to the sacrifice of the various aviation activities on shore. The effect of this policy was to bring aviation in close proximity

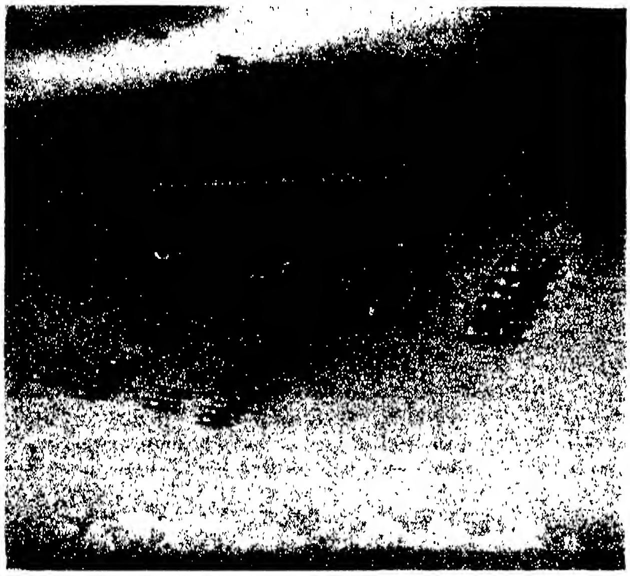
Although seldom forced down at sea, naval pilots carry complete repair and life-saving equipment, including a collapsible rubber boat and a pair of oars

These are the personal views of the writer and in no way express the official views of the Navy Department.

to the rest of the Navy. It educated the aviator to the needs of the Fleet and demonstrated to the Fleet the possibilities of aviation. It promoted the development of aviation in the Fleet as an auxiliary, but on the other hand, it interrupted the development of large flying boats which operate from tenders or shore bases—those big flying boats that are fast becoming one of the most powerful units in the naval aviation of today.

Aviation can no longer be considered only "The Eyes of the Fleet"—it has long since stepped out of that secondary rôle and has become a combatant arm of the Navy. As all of the great powers are admitting, to their intense concern within the last few years, aviation has become an offensive force which must be reckoned with. Moreover, they go further and admit that there is no sure defense against the airplane.

A division of patrol planes launching a salvo of bombs



In Europe today the talk is of air pacts. And the need for air pacts is a tacit admission of the power of destruction that belongs to the airplane and of the inadequacy of defense against it. A chief reason for this inadequate defense is the high speed of all modern planes, both large and small. Theoretically, the big attacking bomber can fly approximately as fast as the small defensive fighter. It can now approach and launch its attack at over 200 miles an hour instead of the hundred miles an hour of not so very long ago. In consequence, its power of evasion, both with reference to anti-aircraft guns and defensive planes in the air, has enormously increased. Its high rate of speed has primarily been brought about by the super-charged motor and the adjustable pitch propeller, which permit a high altitude with a gain of speed instead of a decrease, as was formerly the case.

In the Navy, heavier-than-air aviation is divided into three general classes: planes based on battleships and cruisers; those based on carriers; and the big flying boats which operate from tenders and shore bases.

Our battleships and cruisers carry seaplanes whose main mission is to increase the effectiveness of the ships on which they are based. On the battleships they are called observation planes and their mission is primarily to spot gun fire of the battleships. Aboard the cruisers they are called scouting planes and are used as such.

BOTH of these types are launched into the air by catapults from the decks of their ships and, upon returning from their flights, they land alongside and are hoisted on board. Their value to ships may be visualized when we consider that they serve as fast moving observation platforms, capable of taking any position of vantage. Moreover, they cover vast areas and carry with them efficient radio equipment with which to supply information to their ships.

It is an inspiring sight to stand on the bridge of the leading ship in column, to note the hauling down of the signal to launch planes and, looking down the column of ships, to see what appears to be a salvo of planes catapulted into the air.

In the type of plane carried by battleships and cruisers, the prime requisites are strength for catapult shots and open sea operation, a low landing speed, and good vision for observation. Such aircraft must be equipped with hoisting facilities, the total weight must be within the capacity of the hoisting crane, their span must permit satisfactory handling and stowage aboard ship and, with these restrictions, they must be able to carry all necessary equipment, climb to required altitude, travel at high speed and remain in the air the necessary hours to perform their jobs. In themselves, they have little value as a combatant unit in the Fleet but they furnish a very important and indispensable service.

The second class of planes, those based on carriers, are in a group by themselves, both as to mission and as to type. Our great carriers of today do far more than merely carry planes. Each one in itself is a mobile floating airdrome. The carrier is not designed with the idea that as a ship it will seek combat with other ships, although it has guns for defense. Its purpose is to provide a mobile operating base at sea, for the planes which it carries, so that those planes may be available at the scene of action, ready and equipped to perform their functions as an arm of the Fleet.

We now have four aircraft carriers in our Navy and within the next two years two more will be added. Each carrier has been allotted a complement of planes which consists of squadrons of those types that are best fitted for offensive action against an enemy. Requirements peculiar to planes based on carriers include short take-off runs along the deck, ability to land on board, and spans sufficiently small to enable a large num-

Aircraft carriers *Saratoga* and *Lexington*, anchored off Diamond Head, Honolulu

ber of planes to be spotted on deck. These operating requirements somewhat curtail the full application of all the latest aerodynamic developments and likewise tend to limit the capabilities of carrier-based aircraft; nevertheless they are capable of offensive action of undisputed potency.

The term "striking force" as applied to a special force within the Fleet for inflicting early and effective damage on an enemy, is not normally used. The Fleet itself, as the first line of national defense, is a "striking force" when the need therefor arises. The carrier force, however, by virtue of the potency of its planes, is of its own power and as an arm of the Fleet, a very competent "striking force."

THE third class in naval aviation, the patrol plane, offers even greater possibilities as a striking force, for it flies to the scene of action instead of being transported by a vulnerable mobile airdrome.

During the World War naval aviation was employed generally to curb the submarine menace. Few of the planes so employed sighted and attacked submarines, only a small percentage of these registered damage; still it has been conceded that knowledge of the presence of aircraft in any sea area caused considerable restriction on the operation of submarines. The general name applied to this service and to the class of planes engaged in it was "Patrol." This term has been retained and at present we have patrol planes, the name indicating a particular class of aircraft with definite functions.

This type is the only one that is not restricted in size or performance to conform to the operating conditions peculiar to shipboard aircraft. As a consequence, its potentiality is limited only by the existing aeronautical development. This fact is of vital significance. Today, aircraft of this class greatly surpass those of a few years ago in speed, range, and weight-carrying ability. Its size has greatly increased and as yet the size limit for efficient performance has not been reached. Generally speaking, within the limits of effectiveness the larger the plane the more load can be carried. Put this load into armament, including bombs or torpedoes, and the large plane assumes more formidable possibilities than the smaller plane. Semi-protected sea areas serve as suitable seadromes from which to operate these aircraft. This, together with their large cruising range, enables them to accompany the Fleet and work in conjunction therewith by proceeding from one locality to another to any part of the world. Normally such planes operate from Naval Air Bases located along our coasts and insular possessions. However, to enable them to operate from protected waters, where no shore facilities exist, tenders are provided which furnish the services required. It is through these tenders that greater mobility of large numbers of planes is attained.

Our patrol planes are large flying boats. It may be recalled that a group of them made the flight from San Francisco to Honolulu in January, 1934, a distance of about 2400 miles. Considering their present speed, range, and weight-carrying capacity and also considering their susceptibility for future development along those lines, we can well visualize the usefulness and importance of the big flying boat in connection with the conduct of many naval functions.

THE question has often been raised: "Why bother about building additional warships, when aircraft can bomb and sink them?"

We are familiar with the effect of the torpedo which was employed so generally during the World War. The torpedo has all the effects of a bomb that explodes in a similar position relative to the underwater portion of a ship. We know that it sank merchantmen and that it more or less crippled warships, although it did not in all cases sink them. Modern warships are built with the idea of restricting damage to that small portion of the ship in the vicinity of the torpedo hit. A modern battleship, having been struck by a torpedo, may even continue to carry on a fight very effectively. However, as compared with aircraft, submarines are very few in numbers and extremely slow in speed. For this reason the menace presented by submarines is fairly well localized. If, on the other hand, submarines existed in great numbers and if it were possible to increase their speed tenfold, or to that of a patrol plane, would they not present an entirely different opposition for fleets to consider?

Aircraft bombs are of various weights, including those carrying twice as much explosive as a torpedo. Whether these heavy bombs will sink a ship, put it out of action permanently or temporarily, or merely do partial damage, depends on the efficiency of the protective features embodied in the ship and on the part of the ship in which the bomb explodes when a direct hit is made.

THE effect of aircraft bombs on ships is normally weighed from the viewpoint that they actually strike the ship; however, there is also the torpedo effect to be considered in case they miss the ship and land close alongside. From much published tests that were conducted in the past, the effect of a heavy bomb landing on a ship has led to much controversy. Without going further into the discussion on this point, it can be stated very definitely that the explosive effect of heavy bombs is terrific and that they can do much material damage. The main question cannot and probably never will be answered conclusively to the satisfaction of all. Much will depend on the answer to the following: "Considering the vast expanse of oceans, the relatively small targets presented, the concentrated anti-aircraft batteries opposing, to what extent will ships be subject to aircraft bombing attacks and how accurately can aircraft make bomb hits?"

I am not one of those who believe that because the airplane has become powerful the battleship has become obsolete. So long as any probable enemy has battleships, it will be wise for us to have them also. I do predict, however, that the battleship of the future will be quite unlike the battleship of today. And I am equally confident that as the years go by, the fleets of the world will grow less and less anxious to make themselves easy targets for enemy aircraft.

Do We Hear With Our Eyes?

Eyes Work Where Ears Fail . . . "Lip Reading" a Misnomer . . . Correcting Errors in Understanding

By JACK C. COTTON, M.Sc.
Phonetics Laboratories, Ohio State University

THIS question may seem ridiculous, but recent experiments at Ohio State University demonstrate quite conclusively that everyone often makes use of his eyes in "hearing" the speech of those about him where the ears alone would fail entirely.

An audience sits in a darkened room. In front stands a sound-proof booth equipped with a double glass window. Lights on opposite sides of this window shine directly into the eyes of the audience, thus shielding the speaker within the booth from view. The speech of this person is heard through a loudspeaker after being picked up by a microphone and amplified. An operator directs the speaker by telephone. At the beginning of the demonstration, speech from inside the booth can be understood readily although the speaker is not visible.

While the speech is being heard in this manner the operator turns on a noisy buzzer and switches a low-pass filter into the circuit, thus cutting out the high frequency speech components. In this way the understandability of the speech is reduced almost to zero, as frequently occurs in noisy places, over-reverberant auditoriums, and so on.

The inside booth lights are then switched on. The person within continues speaking, his speech still being as greatly distorted as before, but his face being visible. The ease with which his speech can now be understood is surprising. The experiment can be repeated in various ways to establish the fact that vision is responsible for the greatly improved understandability. The inevitable conclusion is that the eyes supply a large and important element in our understanding of speech under adverse auditory conditions.

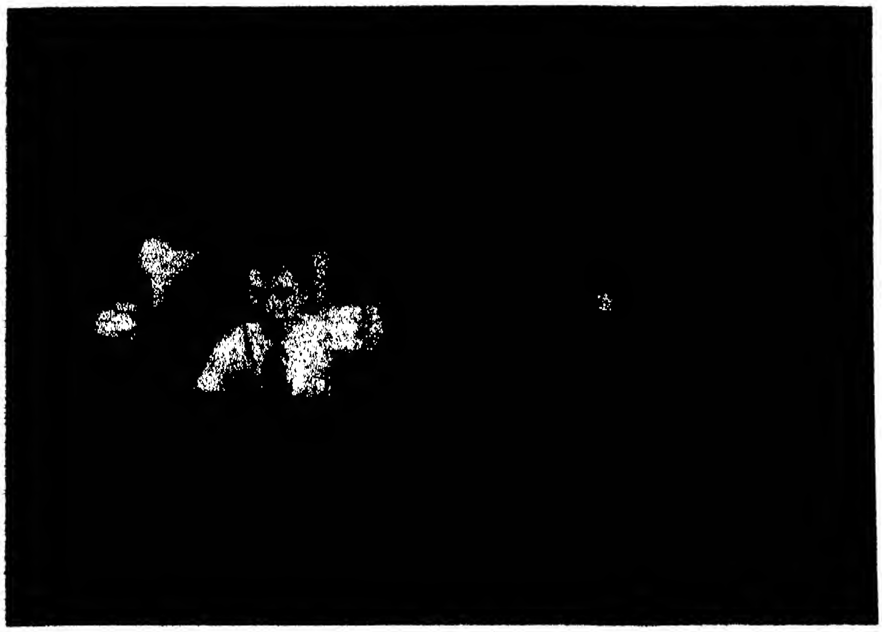
"VISUAL hearing" is receiving considerable attention at Ohio State University. "Lip-reading" (a misnomer, since the movements and expressions of the whole face and other parts of the body enter into visual hearing) has long been used by the hard-of-hearing, but its use in supplementing minor defects of hearing is a fairly recent development. A hearing loss for high-frequency sounds is fairly common and the loss is seldom realized by the possessor. Of the freshmen entering Ohio State University in the fall of 1934, over 13.5 percent had a hearing loss of 20 decibels (approximately 25 percent) or more in one or both ears for a tone of 8192 cycles per second (about one octave above the highest "C" on the piano keyboard). Many of these students also had losses in other parts of their hearing range.

Booths used in hearing tests. The clinician is operating an audiometer and checking hearing test cards. She is also watching a row of lights controlled by those in the booths in response to their hearing of the varying tones of the audiometer

A high-frequency hearing loss makes it difficult to hear or distinguish between such consonant sounds as *p*, *s*, *sh*, *t*, *th*, and so on. Numerous mistakes in speech understanding inevitably result. Many students are handicapped in this way. The situation is similar to that caused by defective vision. Widespread use of simple eye-tests have done much towards the relief of this situation, however, but we are just beginning to see the equal importance of hearing deficiencies which are so commonly overlooked.

Every student entering Ohio State University is given a comprehensive audiometer hearing test. Naturally, in a school where as many as 3000 students may enter in one quarter it is no simple matter to administer reliable tests. An elaborate system is used for handling this large number of students.

The remaining duty towards these students is the provision of a definite course of training whereby their latent visual hearing ability can be effectively strengthened. A motion picture method for accomplishing this result was developed in these laboratories and has been in successful use for the past five years. The films are carefully graded so that students are enabled to progress rapidly in proficiency. Two projection rooms are used on an average of eight hours daily.



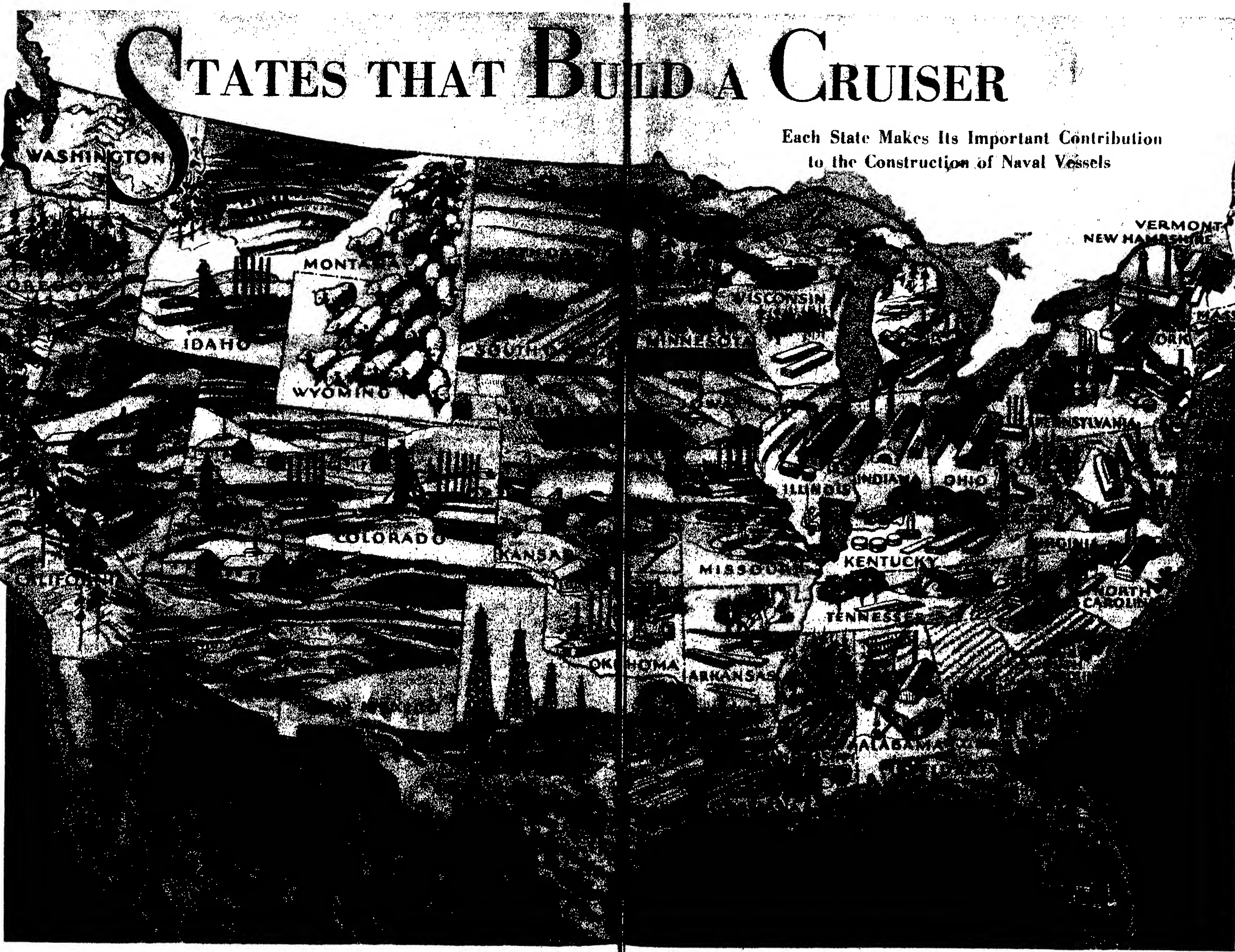
Set-up for demonstrating the importance of vision in speech understanding

STATES THAT BUILD A CRUISER

Each State Makes Its Important Contribution to the Construction of Naval Vessels

Alabama—Iron ore, limestone, coke, pig iron, pipe fittings $25,000
Arizona—Copper ore, silver *
Arkansas—Ash lumber $15,000
California—Sugar pine *
Colorado—Copper ore, lead, silver *
Connecticut — Brass and copper products, lighting fixtures, electric wire, hardware, cutlery, silverware, chain, ball bearings, valves, gages, clocks, counters $295,000
Florida — Cypress, turpentine, and naval stores $15,000
Georgia—Yellow pine, turpentine and naval stores, cotton $46,000

Idaho — White pine, lead $35,000
Illinois—Refrigerating machinery, hardware, valves, limestone, coke, paints $92,000
Indiana — Electric motors, pumps, limestone, alcohol, oak lumber $235,000
Kansas—Zinc *
Kentucky—Fire brick, oak lumber $35,000
Louisiana—Yellow pine, cypress, cotton, sulfur $25,000
Maine — Winches, windlasses, steering gears, capstans $93,000
Maryland—Steel plates, brass and copper, tubes and sheets, switchboard material, canvas, oakum $197,000
Massachusetts — Electric motors, turbines and generators, pumps, fans and blowers, rubber tile, furniture, rugs and draperies, plumbing fixtures, insulating paper, Manila rope, valves, office supplies, tools, leather belting, grinding wheels, navigation instruments $680,000
Michigan—Iron ore, limestone, white pine, plywood, hardware, furniture, soot blowers, tools, copper, paint $260,000
Minnesota—Iron ore, white pine, flax, linseed $92,000
Missouri—Lead and lead products, zinc $46,000
Mississippi—Yellow pine, cotton $25,000
Montana—Copper ore, wool *
Nevada—Silver *
New Hampshire—Ebony asbestos for switchboard panels *
New Jersey— Boilers and super heaters, oil burners, refrigerating machinery, deck machinery, elevators, fans, pumps, plumbing fixtures, switchboard instruments, electric cable, storage batteries, galley equipment, fire extinguishing apparatus, paints and varnish, zinc oxide, glass, steel forgings, babbit, rubber goods $1,175,000
New Mexico — Copper ore *



New York—Electric motors, turbines, generator telephones, communication and navigation instruments, life boats, boat davits, cast-iron radiators, furniture, rugs and draperies, carpets, linens, magnesite floor covering, galley equipment, glass, cork products, tools, foundry supplies, office supplies, scrap metals $1,100,000
North Carolina—Canvas, cotton goods, furniture, spruce and maple lumber $126,000
North Dakota—Linseed $12,000
Ohio—Steel shapes, steel and iron pipe, limestone, coke, glassware, quarry tile, sheet rubber, rubber hose, paint and varnish, anchors and chains, hardware, heaters, evaporators, distilleries, tools $330,000
Oklahoma—Fuel oil and lubricants, lead, zinc $35,000
Oregon—Oregon pine $35,000
Pennsylvania — Steel plates, shapes, pipe, ingots, forgings and castings, coal, limestone, coke, electrical machinery, refrigerating machines, deck machinery, thrust bearings, glass, magnesia pipe coverings, anchors and chains, wire rope, hardware, plumbing fixtures, cast-iron radiators, galley equipment, paints and varnish, alcohol, pipe fittings, tools, steam packing, office supplies, cement $2,130,000
Rhode Island—Machine and hand tools $82,000
South Carolina—Canvas, cotton products, turpentine and naval stores $25,000
South Dakota—Linseed *
Tennessee — Iron ore, hardwoods $25,000
Texas—Fuel oil and petroleum, ash lumber, cotton $44,000
Utah—Copper, silver, lead *
Vermont—Plywood *
Virginia — Iron ore, foundry sand, office supplies $35,000
West Virginia — Coal, coke, steel castings, spruce $163,000
Wisconsin — Iron ore, white pine, plywood $92,000
Wyoming— Wool *

*No amount specified.

FROM farm and forest, mine, quarry, and clay-pit, sheep ranch and oil well, come the materials of which our modern naval vessels are constructed. Visualizing a modern, steel-clad ship as a machine-made product, our tendency may be to forget that fact. Some inlanders may even feel that they have no part in the Navy since they never see one of its ships and perhaps, also, because they can see no connection between their preponderantly agricultural states and those metal monsters which are designed to keep us out of trouble. Yet the factory is only the middle-man. The factory processes the raw materials drawn from our store of natural resources and from our farms. Each state makes its important contribution—some greater, some smaller, depending upon various factors. And, since 80 or 90 percent of the cost of a naval vessel is for labor, general employment is aided everywhere by construction of each naval vessel.

In the map above, our artist has interpreted this nation-wide contribution, and in the panels at each side we have given the details as applied to the construction of a typical naval vessel, the 10,000-ton cruiser. All the products listed are vital. Without any of them—zinc from Kansas, hardwoods from Tennessee, wool from Wyoming, linseed from North Dakota, and numerous chemicals and paints made from farm products—it would be impossible to make this ship into an efficient unit in our scheme of national defense.

The Navy is, indeed, a living entity into which has been poured a life's blood composed of the labor, patriotism, and devotion to a high ideal of international peace of a whole people; and, in the pouring, each hand has done its part.

Oxygen Stars and Carbon Stars

Old Story, New Chapter . . . A Carbon Star with a Vengeance . . . Changes Still a Mystery . . . All Over the Universe Matter Is Evidently the Same

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

RETURNING from our meeting at Paris, we American astronomers found that many interesting things have been discovered in the meantime. Some of these were passed from mouth to mouth at our conferences, and they have appeared in the technical journals, and so belong to the "now-it-can-be-told" class for a general article like the present.

One of these adds another chapter to a long story which began nearly 70 years ago. Father Secchi, one of the pioneers of spectroscopy, observing the stars with a prism in front of his four-inch telescope, discovered that there were two kinds of red stars. Both showed spectra crossed by heavy dark bands, far stronger than the lines of the solar spectrum: but in one variety the bands were sharp at the edge toward the violet and faded out toward the red, while in the other the sharp edge was toward the red and the shading toward the violet. In the later classification at Harvard the former were denoted by the letter M, and the latter by N. The bands in the N-stars were long ago recognized as produced by carbon in some of its compounds; those in the M-stars were identified somewhat later by Fowler, and are due to titanium oxide. More extensive studies, including hundreds of stars, reveal a curious fact. Practically every red star showed *either* the titanium or the carbon bands, but not a single one out of the hundreds showed *both*. What did this mean? The explanation was given 20 years or so ago by the late Professor Ralph H. Curtiss.

BOTH sets of bands are due, not to atoms, but to compounds of various kinds which form at the relatively low temperatures of the coolest stars. Those of the N-stars come from carbon molecules (C_2), or cyanogen (CN), or the simplest possible hydrocarbon (CH), while the M-stars show titanium oxide. Where compounds can form we have to do with chemistry, and the moment we think of the problem in this way the solution is plain. Suppose we were to take a mixture of carbon and of a metallic oxide and heat it to a temperature far hotter than that of any blast furnace, so that the refractory carbon itself was vaporized. With an excess of carbon—as in the industrial furnace—the oxide will be reduced, forming carbon monoxide and the free metal. At a higher temperature the vapors of carbon and the metal would appear. But if there was not enough carbon it would all be used up in reducing a part of the oxide, and there would be no carbon vapor, but only that of the metal and its oxide—partly decomposed perhaps into the metal-vapor and oxygen. These two situations—corresponding to the familiar distinction between a reducing and an oxidizing atmosphere—represent exactly what we find in the N- and M-stars. One might inquire why we do not find spectroscopic evidence of the carbon monoxide, which ought to be present; but the strong bands of this gas all lie far in the ultra-violet where we cannot get at them in the sun or stars because of the ozone in the earth's atmosphere. Free oxygen, too, has its strong lines out of reach, and the next strongest far in the deep red—very hard, though not impossible, to observe in the stars.

IT might be that in some particular star the amounts of carbon and oxygen were perfectly matched so that, on combination, each used up the other. In this case neither compounds of carbon nor metallic oxides would form, except in small amounts, and there would be no conspicuous bands in the spectrum. Detailed calculations show, however, that if either element were in excess by so much as 1 percent, fairly strong bands would appear, so that this perfectly balanced case would be very unlikely to be met with.

As a matter of fact, stars of spectrum M are about 100 times more numerous than those of class N of the same apparent brightness. It follows that excess of oxygen is the normal condition in the star, and that excess of carbon is rare. Why such differences of composition should exist no one knows. The observable N-stars are all of great absolute brightness, remote from the sun, and are scattered thinly in space, so that most of them appear in the Milky Way or the adjoining parts of the sky. Two or three of them are just visible to the naked eye.

This distinction between the "oxygen stars" and the "carbon stars" is the most conspicuous of all spectral differences, so long as the temperature is low enough to permit the formation of compounds in the atmospheres. For the hotter stars it seems to disappear—at least it was long sought for in vain. We know that the sun is an oxygen star, for the bands of titanium oxide appear faintly in the spectrum of sunspots where the lower temperature allows the compounds to form. The sun is therefore a member of the majority but, till the other day, no hot carbon star had been recognized. This has been done at last by Dr. Berman, formerly a student at the Lick Observatory and at Harvard, and now on the staff of a junior college at San Mateo, California, who has made a very careful spectroscopic study of the remarkable variable star R Coronae Borealis.

This is one of the strangest stars in the sky. Normally—sometimes for years together—it is of the 6th magnitude with insignificant fluctuations. At irregular and quite unpredictable intervals it drops fairly rapidly as far as the 11th or even the 13th magnitude—only 1/600th of its usual brightness. It may remain faint for but a few weeks or for many months—then it returns to normal, usually more slowly than it faded.

THE spectrum at maximum is of class F7 on the Harvard system—not very different from the sun's, except that it shows conspicuously the characteristics of a super-giant star. Like almost all other intrinsically variable stars, therefore, it is of high luminosity—greatly exceeding the sun, except perhaps at the bottom of its deeper minimum.

When the spectrum is compared in detail with that of an ordinary super-giant star, such as Gamma Cygni, Dr. Berman finds two notable differences: The hydrogen lines are very weak, as has been noticed before, and a few faint lines of carbon in the blue, which are inconspicuous in ordinary stars, are here remarkably strong. These lines are absorbed by free carbon atoms. The

bands due to carbon molecules are also present but weak. By a detailed study of more than 600 lines, Dr. Berman has analyzed the atmosphere and determined the amounts of more than 20 elements which are present. For the metals the relative proportions are strikingly similar to those which occur in the sun, but carbon is enormously more abundant and hydrogen less so.

A direct comparison with Gamma Cygni (which, being a highly luminous star, is a fairer standard of comparison than the sun) indicates that, in the latter, the atmosphere is composed of 99 percent hydrogen (by number of atoms), 0.5 percent of carbon, and the same number of atoms of all the metals together, while in R Coronae there is 27 percent of hydrogen, 69 percent of carbon and 14 percent of metals. Here is a carbon star with a vengeance.

IT is unfortunately very hard to determine the amounts of oxygen in these stars, since the only available lines lie so far to the red that exceedingly long exposures would be required to photograph them. There can be no reasonable doubt, though, that carbon is in excess and that this star, if it could be cooled down, would turn into an N-star with very strong bands of carbon compounds. The discussion also indicates that the temperature of the star's surface is 5400 degrees—slightly lower than the sun's—and that the atmospheric pressure and the surface gravity are of the order of 1 percent of the values which prevail on the sun. The actual brightness can only be roughly estimated, but it is probably about 1000 times the sun's—making the star 20 or 30 million miles in diameter.

The extraordinary and erratic changes of brightness to which this star is subject are still a mystery. A few spectra taken while it was faint 10 years or so ago showed great changes, many bright lines being present. The star has grown faint again this year and, if enough good spectra are obtained, we may get some hint as to the cause of the variation. Whether the abnormal abundance of carbon has anything to do with it we do not know, but one fact is suspicious. There are 10 other stars which vary in brightness in the same peculiar fashion. Some of them have spectra of class G—not very different from R Coronae, though existing observations are not sufficient to detect whether the carbon lines are strong. The others are of class R and show carbon bands, though with less intensity than the N-stars. This suggests strongly that these strange objects may all be hot carbon stars. The rest of them unfortunately are so faint that detailed observations will be difficult.

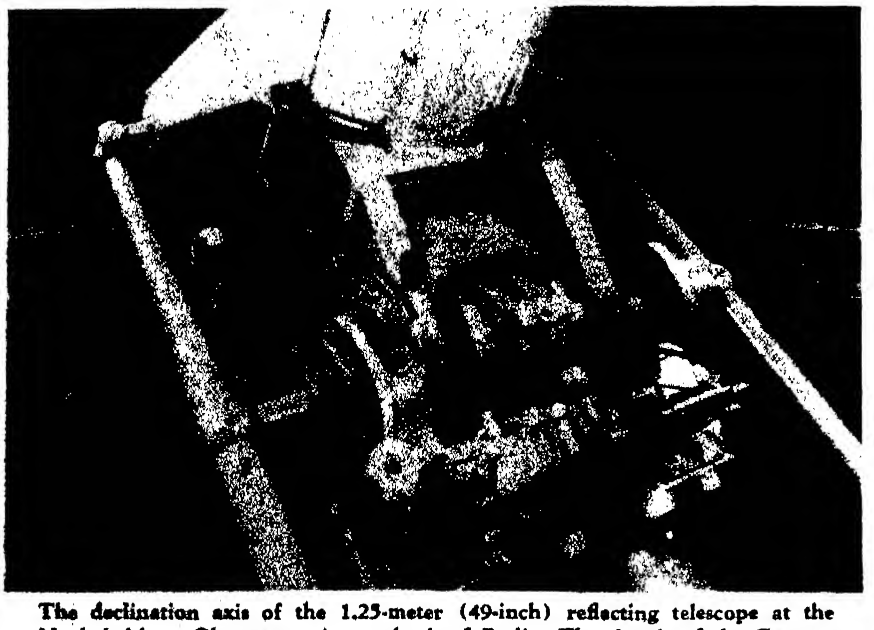
Whether carbon stars are to be found at still higher temperatures is still unknown. Among the Wolf-Rayet stars—the hottest of all—remarkable differences have recently been detected by Beals of the Dominion Observatory at Victoria. They fall definitely into two parallel sequences, one distinguished by bright "bands" (which really are widened lines) of nitrogen, the other by similar bands of carbon. The range of atomic excitation, and hence doubtless of temperature, is large in each series, and about the same for the two, so that it appears clear that they represent different kinds of stars of the same temperature. They are, however, enormously too hot for compounds of any kind to form—from 30,000 to 50,000 degrees, or even more—and no reasons can at present even be suggested why nitrogen should show up in one set and carbon in the other. In this case oxygen appears in the carbon stars and not in the nitrogen sequence, which makes the puzzle all the greater. While this new problem remains to be solved, an older one is rapidly nearing completion—namely, the composition of the gaseous nebulae.

Since Bowen's fundamental discovery, we know that the lines in their spectra are mainly of the "forbidden" type—which are emitted only by an exceedingly rarefied gas. Now atoms of all sorts have ordinary spectral lines, but only a limited number of them (which have spectra more complicated than the average) can show forbidden lines. Among the lighter atoms these are carbon, nitrogen, and oxygen; then come silicon, phosphorus, and sulfur. By removing an electron from the atoms, fluorine is added to the first group, in place of carbon, and chlorine takes the place of the silicon; another ionization puts in neon and argon. A year or so ago neon was recognized in the nebulae by the presence of forbidden lines of its atoms, some with two electrons missing, others with four. More recently, highly ionized argon has been detected in the same way. Now comes a note by Mr. Stoy, an English Commonwealth Fellow at the Lick Observatory, reporting the discovery of forbidden lines of chlorine. They arise from the doubly ionized atom, and lie in the green at 5538 and 5518A. They are so faint that an exposure of 10 hours was required to get a measurable photograph, but their reality appears assured.

THIS discovery is of universal interest since it is the first direct evidence of the existence of chlorine in an astronomical body. Though the element is so familiar in everyday life, it is not really very abundant—most of it on earth is dissolved in the sea as common salt. But this would not prevent its recognition spectroscopically, were it not that its strong lines are in the inaccessible ultra-violet, and its next best too far in the red.

All the first 30 elements, in their natural order, have now been identified in the depths of space. Those which remain unidentified are all rare on earth and we know good reasons why they should be hard to detect with the spectroscope. The last outstanding element of reasonable abundance was chlorine. Now at last it has been detected, and one more confirmation given to the conviction that the general composition of matter is everywhere the same throughout the universe.

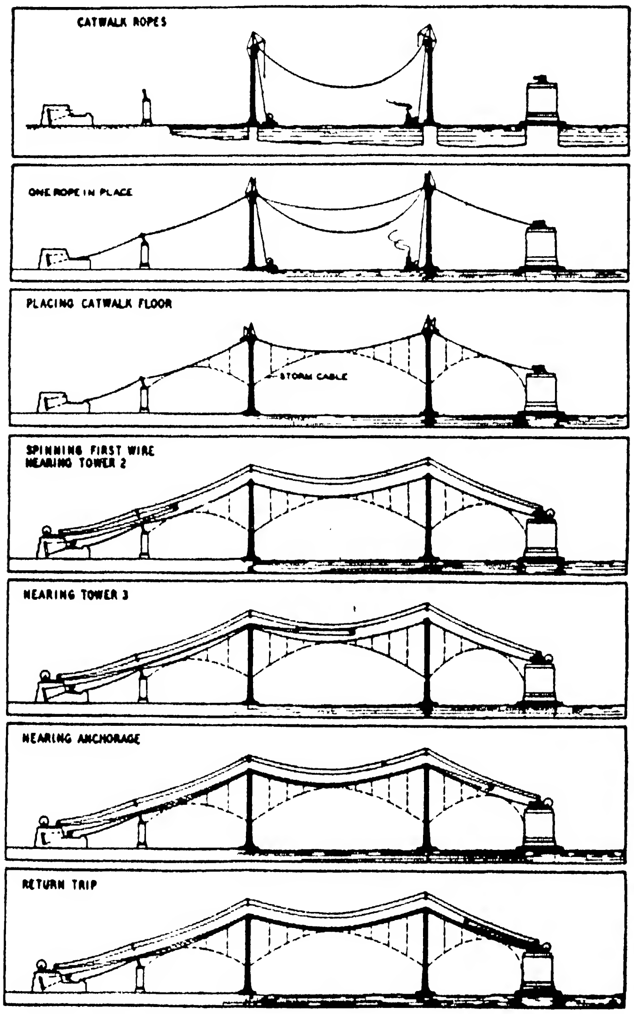
The central stars, whose ultra-violet radiation sets the nebulae shining, are exceedingly hot. Professor Menzel has just stated that the stars' temperature must be at least 100,000 degrees, Centigrade.—*Jamestown, Rhode Island, Sept. 2, 1935.*



The declination axis of the 1.25-meter (49-inch) reflecting telescope at the Neubabelsberg Observatory in a suburb of Berlin. The details of the German (Zeiss) design will seem unfamiliar to most American amateur telescope makers

STEEL BRIDGE CABLES SPUN

Four Strands at a Time . . . Taken From 60-Mile Reels . . . Shuttled Over Three Towers . . . 4366 Trips of the Wheel



Seven drawings that show diagrammatically the steps in erecting the catwalks (engineers refer to rope-twist steel cables as "ropes"), and spinning the cables over the huge saddles at the tops of the towers of the suspension span

Right: The wires over the strand shoes near the edge of this illustration have been tightened to the correct tension. Above them is the wheel ready with two loops of wire for the return trip to the anchorage

Left: A close-up view of strand shoes in place, ready for the beginning of the spinning operation. Shoes are fastened to steel girders firmly embedded in concrete

Below: A general view of the construction work, after the catwalks were completed and before spinning. Note the "gallows frames" provided to support the wheel cables

Right: One of the magneto telephones at the end of the north catwalk. There are 52 telephones on the walks and towers, by means of which constant communication is carried on during the cable spinning operations

LIKE THREADS

By ANDREW R. BOONE

OPERATING with the precision of fine machinery, four wheels, each five feet in diameter, are spinning the barrel-size cables from which will be suspended a two-mile section of the San Francisco-Oakland Bay Bridge. [See also SCIENTIFIC AMERICAN, March 1935, page 124.—EDITOR.]

In the spinning operation, starting at the San Francisco anchorage, two bights, or loops, consisting of four strands of wire the size of a pencil are taken from two reels, each bearing 60 miles of wire, and passed around the spinning wheel. The haulage machinery is set into operation and the wheel rolls away across the main bay channel. Arriving at the center anchorage these loops are removed from the wheel, passed around strand shoes, which are fastened to steel girders embedded in concrete, new loops are taken from reels at that point and the return journey is made. The process will be repeated until the cables are complete, and the same method will be used on the eastern half of the bridge, between the central anchorage and Yerba Buena island, located in mid-bay.

Each spinning wheel is suspended by a gooseneck from an endless trolley rope, and contains two grooves. Loops of wire are shuttled over the tops of three towers on its long journey. Two wheels operate on each of two cables, leaving each end simultaneously and meeting in the middle of the bridge going in opposite directions. The wires are laid parallel and with the same sag as a guy wire carefully surveyed into position.

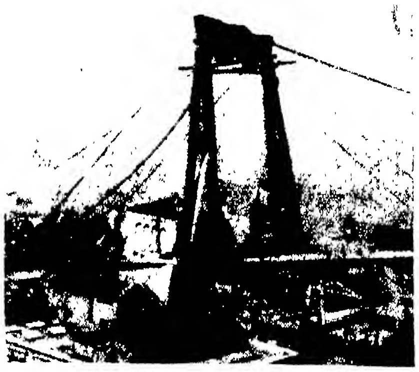
In order to make sure that all of the 17,464 wires making up one cable take their proportionate parts of the entire load, all are cut to the same length. Whenever the wire on one reel is used up, the loose end is spliced to the end of a wire on another reel, and the spinning continued.

Finally, when all the wires of one cable have been spun, a careful survey will be made to determine the correctness of the work. A powerful squeezing machine will then be moved along the length of the cable, and within its jaws this loose bundle of wires as big around as a barrel—will be squeezed down to the smallest possible diameter. As this squeezing progresses the cable will be gripped at intervals by seizing bands and held in a circular form. Later, when other elements of the bridge are completed, the cables will be wrapped by wire wound spirally. This wrapping, together with galvanizing and paint, will serve to protect the cable against deterioration by the elements.

Oddly, the cables are being spun shorter than they will be when loaded, since the steel will expand due to stresses set up by the great weight. Mathematical calculations determine the exact positions where the cables must be spun so that later, when the weight of the bridge itself is supported by them, the cables will stretch and the towers will bend to bring the bridge to its planned elevation. At one point the cables are being spun 22 feet below the final elevation and at another 15 feet higher.

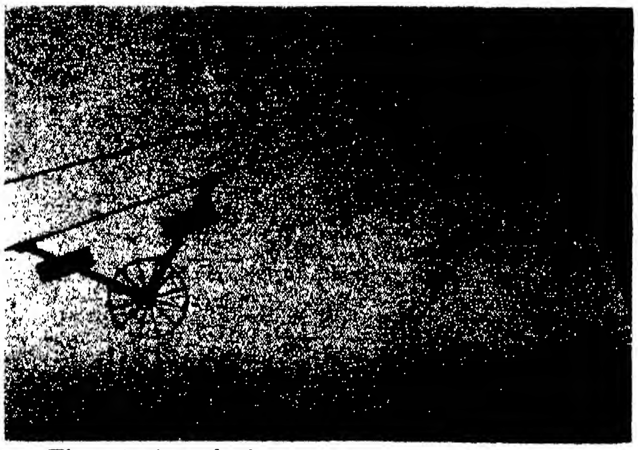
Workmen on catwalks, each 10 feet wide and constructed of wire mesh and cables, check the passage of the spinning wheels every 230 feet. At those intervals are located gallows frames, rectangular metal frames to which are secured the endless haulage lines which pull the spinning wheels. The catwalks are considered to be both fire and wind proof, since they are made of metal and "tied down" by storm lines. Workmen may cross from one catwalk to another over steel bridges.

The cable wire was brought from eastern mills in coils containing 3500 feet of wire. At San Francisco the Columbia Steel Company rewinds the wire into larger reels, each containing 16 tons or 60 miles of wire. Each cable will be composed of 37 strands, each strand containing 472 wires. The spinning of each cable will require 4366 trips of the spinning wheel.



Lower left: The spinning wheel arrives at the San Francisco anchorage and the loops of wire are removed from the grooves. These loops are then placed in the strand shoe below the wheel

Upper right: Workmen fastening the guy cables that hold one of the gallows frames securely on the catwalk



The spinning wheel starts on its return trip. Wires previously spun hang just below the catwalk hand-ropes

SYNTHETIC RUBBER

FATHER NIEUWLAND of the Congregation of the Holy Cross (C.S.C.), the author of the accompanying article, was born in Belgium but was brought to America when an infant. He was educated as a botanist at Notre Dame University but while doing graduate work at the Catholic University in Washington he undertook chemical research on acetylene and has pursued it ever since. This led to his discovery of Duprene, a synthetic rubber which is superior to natural rubber in many ways, and nearly as good in every other way. It resists heat, light, oils, chemicals, and oxidation much better than natural rubber.

According to Rev. Father Eugene P. Burke of Notre Dame, Father Nieuwland still goes on botanical forays; he goes often to the movies and annually to the circus; often seeks a quiet corner in the Science Building to smoke the most ill-smelling pipe in St. Joseph County, while reading detective stories; plays the guitar, and has defined a gentleman as a man who can play the saxophone and doesn't. He is a hater of shams.

For his successful research in chemistry Dr. Nieuwland was honored last spring by the gold medal of the American Institute (Scientific American, April 1935, page 173), and later by the Nichols Medal of the American Chemical Society.—*The Editor*.

THERE is something particularly fascinating about discoveries in science. Not so very many years ago people were known to travel many miles to hear and see a radio. Today we look forward to the perfection and popularization of television. Who has not heard or read about heavy water, neutrons, positrons, cosmic rays, and many other equally mysterious and wonderful things without wondering what eventually will be done with them? Well do we know that the most abstruse scientific truth discovered today may tomorrow be put to practical use.

Occasionally we hear or read about the successful "synthesis" of some commercial commodity. At present we have synthetic dyes, medicinals, plastics, textiles, rubber—to mention but a few. These products are not only important to us as individuals in our daily lives, but they are most important to us collectively as a nation. Synthetic chemistry is just one phase of applied chemistry and every synthetic product has its own lengthy history—a tale of many years of patient study and experimentation by many scientists the world over.

Synthetic rubber-like materials, for example, have been known for almost three quarters of a century. The early work was carried out in European laboratories and was of theoretical interest only because the products were decidedly inferior to natural rubber and far too expensive. It is quite obvious that before any synthetic material can become a commercial commodity it must be able to compete with the natural product, both as to quality and price, or else be so superior (at least for special purposes) as to be able to command a better price. Not infrequently, however, it happens that a valuable synthetic material has no known counterpart in nature. Witness, for example, the multitudinous synthetic dyes, of every hue and color, which are commodities today but which have not been isolated from any natural source. The same is true of many of our medicinal products. Synthetic rubber, on the other hand, must compete with a very highly developed natural product. It is to be remembered that science, and particularly chemistry, has been very extensively applied to improving upon natural rubber.

A piece of unvulcanized synthetic rubber

A synthetic rubber was actually produced and used in Germany during the late war but, as far as is known, was used only during that crisis: for, with the advent of the Armistice, Germany was again able to obtain ample supplies of natural rubber and the synthetic material was once more relegated to the chemical laboratory. Like the modern Duprene, German rubber was synthesized from acetylene. Before proceeding further it should be remembered that acetylene itself is a synthetic material. At present practically all of the world's supply of acetylene is made from coke, lime, and water.

THE steps involved in the synthesis of German rubber were essentially the following: The acetylene was combined chemically with water to yield acetaldehyde, and this was then combined with oxygen from the air, giving rise to acetic acid. (Much of our acetic acid is still made in this way.) The acetic acid was then converted to acetone and this, in turn, reduced to a compound known as pinacol. Dehydration of the pinacol yielded dimethylbutadiene, known also as methyl isoprene. This material is a volatile, non-viscous liquid. To be made into a rubber it must be polymerized; that is, it must be made to react with itself. During this process, which is promoted by light and traces of air or other chemical agents, the liquid dimethylbutadiene increases in viscosity and finally becomes solid and elastic. Notice that, in all, six distinct chemical processes are involved, starting with acetylene and including the final polymerization.

Time, space, and a lack of definite information prohibits a discussion of the value of this rubber. Nevertheless, while it is not made today, one plant in Germany was reported to have had a manufacturing capacity of about 150 tons of this product per month. Most of that which was actually used was fabricated into solid tires and, as a hard rubber, into battery jars, and so on.

The process involved in the manufacture of Duprene, while also involving acetylene as a starting material, is entirely dissimilar from the German rubber process just described. Furthermore the finished product is chemically different from other synthetic or natural rubbers.

Duprene is the outgrowth of a purely theoretical study of acetylene reac-

FROM A GAS

Practical Application of an Abstruse Scientific Discovery . . . Opens the Way to a New Industry

By J. A. NIEUWLAND, C.S.C.
Professor of Organic Chemistry, Notre Dame University

tions. As early as 1906 we noticed that a reaction took place when acetylene was passed into a solution of copper and alkali metal chlorides. There was no violent reaction, no liquid or solid was formed. But there was an odor of something new! A slim thread of evidence indeed. Since no product was isolated it was believed that a new gas had formed whose odor was constantly detected. For the next 14 years experimentation was continued at frequent intervals in an attempt to increase the reaction rate so as to obtain the reaction products in a quantity sufficient for isolation and study.

Finally ammonium chloride was substituted for the alkali metal chlorides. When acetylene was passed into a solution or mixture of cuprous chloride, ammonium chloride, and water, the reaction proceeded much faster and large quantities of acetylene were absorbed in a short time. To our surprise an oil was formed, along with the gas previously noted. In 1921 it was found that this oil is divinylacetylene, a new compound formed by the chemical union of three molecules of acetylene. Divinylacetylene proved to be a very reactive substance. While examining this compound it was found that treatment with sulfur dichloride produced an elastic material resembling natural rubber in some respects, though too plastic for practical use.

IN 1925 an Organic Chemical Symposium was held in Rochester, New York, which I attended and before which I had occasion to refer incidentally to some of these new acetylene reactions. Representatives of E. I. Du Pont de Nemours and Company became interested in this work, and arrangements were made whereby they might take over the commercial development of these materials. The possibilities of the divinylacetylene rubber were first studied, but this proved to be disappointing. These products did not retain their elasticity for any length of time and means to correct this fault were not found.

In the meantime, chemists of the Du Pont company were investigating the gaseous material first observed in our study. Fortunately our belief that this gas could be produced in quantity proved correct. This product was soon found to be monovinylacetylene, a compound formed by the union of two molecules of acetylene.

The reactions leading to mono- and divinylacetylenes are catalytic: that is, they proceed through the agency of a catalyst. A catalyst is a substance which promotes a chemical reaction without itself appearing to undergo chemical change. Theoretically at least a catalyst is never consumed. The mixture of cuprous chloride, ammonium chloride, and water, constitutes a catalytic system which brings about the reaction of acetylene with itself to produce mono- and divinylacetylenes—the first a gas, the second an oil. By controlling certain physical factors either product can be made to predominate. This is extremely fortunate because the monovinylacetylene alone is useful for the production of Duprene.

In chemical research one discovery generally leads to many new problems. It is only by following each and every one of these to its logical conclusion that a problem is completely solved. We knew how to prepare mono- and divinylacetylenes. An efficient catalyst had been discovered. Divinylacetylene could be made into a synthetic rubber but the products so produced had proved to be commercially impractical.

WHILE the study of monovinylacetylene was in progress in the Du Pont laboratories, it was found that this gaseous compound could be made to react very readily with hydrogen chloride (from hydrochloric acid) to produce a new volatile liquid known as chlorobutadiene or chloroprene. On standing for a few days chloroprene undergoes rapid polymerization. The liquid compound increases in viscosity and finally is changed into a plastic substance which can be vulcanized by heating to form an elastic, non-tacky, tough material—a synthetic rubber of excellent quality. This new rubber is now well known under the trade name of Duprene.

At the present time Duprene is more expensive than natural rubber. However, Duprene lends itself to many uses for which natural rubber is unsuited. It is remarkably resistant to gasoline, kerosene, oils, ozone, air, acids and so on, thus opening many new avenues in rubber technology. As has been pointed out previously, these unique qualities create a synthetic rubber industry in times of peace—an industry which may be easily expanded in periods of war or during other national emergencies.

It is apparent that the raw materials needed for the manufacture of Duprene are readily available in our own country. Coke and lime for acetylene, salt for hydrochloric acid—these are the necessary basic materials.

Chemistry has pointed the way to a new industry and has once more contributed to our national self-sufficiency.

Chemical reactions in the manufacture of Duprene take place here

Prehistoric Fingerprints

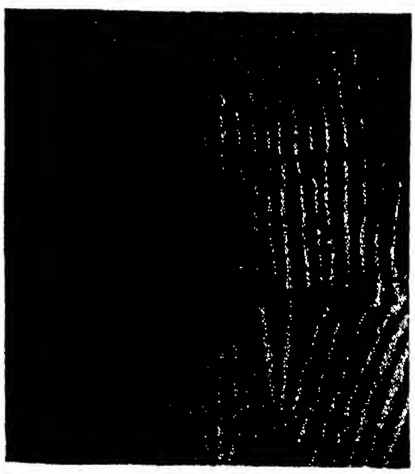
Rock Carvings on an Island Near France Now Believed to Have Been Symbols of Fingerprint Religion

By B. C. BRIDGES
Superintendent, Bureau of Identification, Alameda, California, Police Department

FINGERPRINTS are now universally recognized as an infallible means of identification, and as a modern utility, their worth is unquestionable; but their present-day practical status is only a portion of the rôle they have played in the affairs of mankind during the past. In Egypt, Assyria, Persia, China, Japan—in fact, in nearly every country—their records survive; not housed methodically in prosaic filing cabinets, but imprinted here and there where time's scroll was touched by the hand of romance.

Looking backward across the vista of years, through the eyes of fancy, we see fingerprints faintly outlined on the illumined pages of hallowed, once-forbidden testaments. Dimly they still endure in hardened clay of oddly fashioned pottery shaped by hands that perished with Herculaneum and Pompeii. As mute evidence of forgotten crimes, they blacken the stone treasure chests where thieves, long dead, broke in and plundered the tombs of ancient Pharaohs.

However, the age of even these prints becomes trivial when compared with the petroglyphics of Gavr'inis—stone carvings believed to be copies of fingerprints, and conservatively estimated as being at least 30,000 years old.



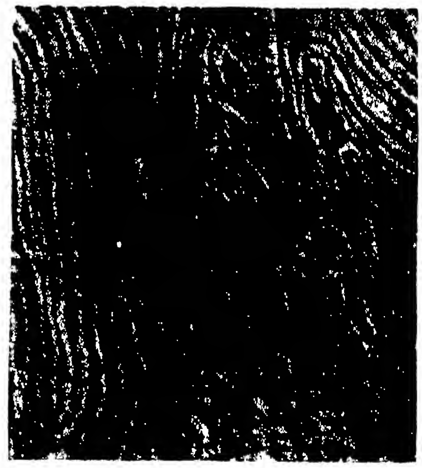
The rock carvings closely resemble the loops found in finger prints

Although their discovery on the little island of Gavr'inis off Morbihan, France, was made some time ago, they were not at first recognized as fingerprints. The original find uncovered some megalithic monuments hidden beneath earth mounds, while further excavations revealed subterranean passages, spacious galleries and chambers paved with flagstones and braced with vertical stone supports. Many of these rock surfaces were inscribed with strange markings which greatly intrigued the archeologists. They at first appeared incomprehensible. The dominating figures were concentric circles, half-circles, elliptics and spirals, seemingly placed together without order. They resembled the dolmens in Irish sculpture, particularly those of Lochcrew and New Grange. Without doubt the tools used in their reproduction were stone implements.

THEY were considered by some to be Druid emblems, while others saw in them alphabetical signs similar to those of the Phoenicians, Celts or Etruscans, and felt that they might have some connection with the famous Stonehenge megalith.

An acceptable explanation was found in the conclusion that the carvings represented fingerprint patterns. This was not so surprising, even considering the great age of the records. Reproductions of the human hand are found in many caverns of the Spanish Pyrenees, ornamented during the paleolithic age, as well as in traces left by earlier inhabitants of America. Likewise, Pre-Columbian engravings were discovered in 1893 on the side of a rock near Lake Kejimkoojik in Nova Scotia, representing a hand with definite indications of palm and finger ridges.

It is possible that the ancient pseudoscience of palmistry as practiced in India, Chaldea, Egypt, and among the Jews and Chinese, may have had its influence on the early observation of epidermic anatomy. Furthermore, cooking utensils, water jugs, and so on, were made from clay by aboriginal



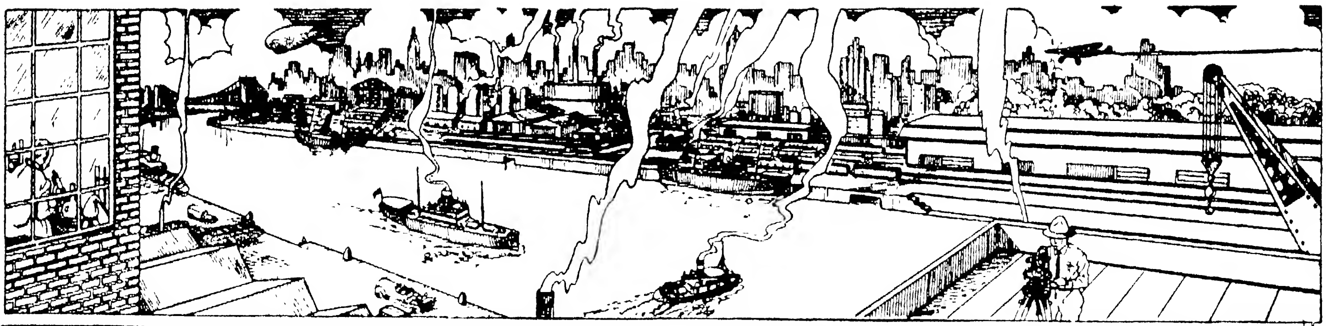
Compare these with the details of your own finger and thumb tips

savages. We can not suppose that these primitive potters failed to notice the impressions of their hands, which in many cases must have remained on the finished product as accidental decoration. When once attention had been called to these markings and their ornamental character, the impulse to reproduce them is quite understandable.

Further consideration of the engravings in question only serves to strengthen the conviction that they are the replicas of hand and finger designs, and when placed side by side with similar sized reproductions of actual fingerprints they present what would seem to be proof of real identity.

The one great factor common to all peoples in all times, influencing their arts and practices, is some form of Faith. In view of the innumerable archeological specimens that feature digital tracery, found in such widely separated places and various ages, it might be justifiable to postulate the pre-existence of a mystical, universal religion with fingerprints as one of its salient symbols.

The Gavr'inis carvings, as related to modern dactyloscopy, are unique, to say the least, but whether their significance may be symbolic or decorative we cannot say. However, we must perforce accept the concrete evidence that Neolithic man has shown in his dolmen sculptures a sense of observation and a fidelity of reproduction which many authorities had considered absent in the primordial races; and that the skin structure of the hands of men in the Neolithic age was the same as that of today.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University

A. E. BUCHANAN, Jr.

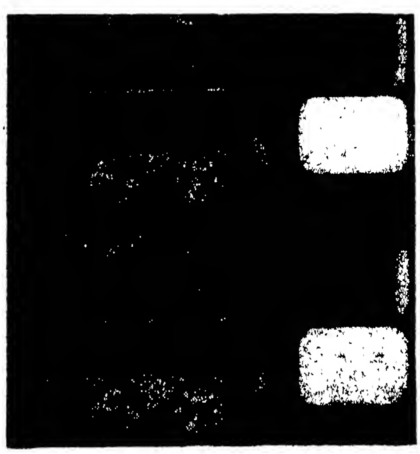
Lehigh University

Movies of Racing Car Instruments

When Sir Malcolm Campbell drove his redesigned *Bluebird* at a speed of more than 300 miles per hour on a dry lake bed in Utah recently, he made use of a movie camera to record the readings of his instruments. Hitherto, Sir Malcolm says, it has been impossible for him to take his eyes off the course when making such great speed and therefore he has never known what the reading of any of his instruments has been. Naturally he is especially interested in the revolution counter, for only the reading of this instrument can give him some idea of the percentage of wheel-spin when compared with his officially timed speed.

The apparatus is housed in a cabinet approximately three feet by eight inches and is 10 inches high. One end of this has a duplicate chronometer, revolution counter, oil and blower pressure gages, mounted on a board, which are illuminated by three 24 watt lamps, the current being supplied from a six-volt accumulator.

The camera is a specially constructed Ciné-Kodak 8 driven by a six-volt electric motor, a feature of its construction being that it can be instantly removed from the cabinet for reloading with film or testing, without breaking any connections, as it is fixed in position by a special type of plug which not only locates the camera so that it is in correct focus, but also makes the electrical connections.



Movie shows racing car instruments

The film used is Super-Sensitive Panchromatic and is 100 feet in length, which will give 8196 separate pictures, each .173 by .130 inch. The exposure is made at *f*/3.5 at eight frames per second, instead of the usual 16 frames per second, so as to provide as long a run as possible without changing the film in the camera.

After processing, the film can be projected onto a screen up to two by three feet or even larger.

HUMAN HORSEPOWER

A 160-pound person, climbing an ordinary flight of stairs at the rate of one step per second, exerts approximately the energy required to lift one end of an upright piano, according to Dr. S. Calvin Smith, author of "How Is Your Heart?"

Oxygen Tent with Windows

Oxygen therapy is today an indispensable part of a physician's practice and is also used extensively in hospitals in the treatment of such cases as asphyxia, asthma, pulmonary and heart diseases, anemia, and diabetes. Administering this life-sustaining gas has heretofore been so expensive that many patients have not been able to pay, except in part, for their treatments.

A new machine, the Oxygenaire, manufactured by the American Hospital Supply Corporation, has been designed to overcome the drawbacks of the older types, according to the *Du Pont Magazine*, keeping the patient foremost in mind.

It is a completely assembled unit, available for instant use, and can be stored in a space of less than two by three feet. The oxygen is fed from a regular tank resting on the chassis, and it is regulated by a gage that indicates a flow of one half to 15 liters per minute. The simplicity of operation is extended to the air-conditioning system which works on the convection principle. Ice and soda lime are stored in the cabinet and the patient provides the heat. The demountable canopy is made of non-conductive material and has a capacity of more than ten cubic feet. The whole is sturdily constructed to give long service.

More comfort in an oxygen tent

The Oxygenaire is said to operate at one half the cost of the older units. It requires no electric power, making it doubly valuable in case of emergency. It contains no motors or blowers and is absolutely silent, offering no annoyance to the patient on this score and insuring safety from sparks and other fire hazards. In the southern states, particularly, it has come into favor because it maintains in the tent a humidity of 50 percent and a temperature of 65 degrees, Fahrenheit, or less, no matter how warm and uncomfortable the air outside may be.

The mental ease, comfort, and safety of the patient are assured by this machine. The roomy tent allows him to assume any desired position and to change it at will. The feeling of confinement so harmful to those bed-ridden for long periods has been avoided to a considerable extent by the unimpaired light and vision afforded by the numerous large windows. There are seven in all: six, 16 by 18 inches; and one, 16 by 20. "Plastacele" was chosen by the manufacturer for these windows because it is light in weight, transparent, durable, and easy to fabricate.

Redistilled Magnesium

To the layman it may sound strange to hear of a metal being distilled. That, however, is exactly how the useful, light metal, magnesium, is produced. Now, chemists have discovered that by distilling the

Navy Day

APATHY seems a predominant American trait—apathy toward many of the things that count, coupled with a belief in the power of wishful thinking as a means of solving difficult problems. Nowhere has this characteristic been more noticeable than in connection with our Navy, in particular, and the armaments question generally. As a nation, we have not faced naval facts squarely—until recently. Now that we are beginning to understand the needs of the Navy and have taken steps to fill those needs, there is good reason for us to manifest our individual and collective interest more forcefully to the end that we do not slip again into a fatal apathy.

It is good to note, therefore, that there has just been organized a Citizen's General Navy Day Committee to promote a wider observance of Navy Day, October 27, and thus bring about a new understanding of the Navy. As this Committee—composed of over 30 leaders in various walks of life in America—is sponsored by the Young Men's Council of the United States, it is fitting that we quote here part of a statement recently made by the Council's National President, Robert J. S. LaPorte:

"The policy of the Young Men's Council of the United States, in regard to our Navy, is: We do not advocate huge Armaments. Neither do we advocate disarmament by example as a means of securing peace. We advocate insuring peace by what we may term the balanced armaments method, which has many advantages. By following it we can, by limiting armaments, reduce their cost, and by balancing them among the various nations make war at least improbable.

"We urge our government to do everything within its power to effect another naval armaments limitations treaty. Failing at that, we demand that our government build and maintain a Navy second to none."
Editor.

commercial metal over again, they obtain a product that is much more chemically active than the ordinary metal. It decomposes water at the ordinary temperature, the reaction proceeding for several hours until the metal becomes coated with magnesia. On exposure to pure and dry carbon dioxide, the metal gradually absorbs the gas at the ordinary temperature with formation of a small quantity of magnesium carbide. It should be only a question of time before the unique properties of the re-distilled metal establish new uses for it.—*A. E. B.*

Pose Your Own Portrait

IN the September, 1931, issue of SCIENTIFIC AMERICAN was described a system of photography in which the sitter actually posed himself in a desired position and could see his image reflected in mirrors exactly as it would ultimately appear in the finished portrait. Now Luther G. Simjian has announced a noteworthy improvement on this portrait system, in which the sitter has the choice of innumerable positions, rather than the five poses available with the older set-up.

The new equipment, shown in the accompanying photograph, includes a central cabinet provided with a mirror, behind which is located the camera. On each side of the central cabinet is a small movable cabinet also containing mirrors which are mechanically connected so that, as the cabinets are moved back and forth, the mirrors always remain at the correct angle to reflect to the sitter the image which is formed on the mirror in the central cabinet. Thus, for example, in the accompanying photograph, the young lady is posed for a full profile view. Looking directly into the mirror in the right hand movable cabinet she sees the image which is formed on the mirror in the central cabinet, and thus can vary her position just as she pleases to obtain the best angle. When the operator presses the button, the central mirror drops, the camera shutter is actuated, and the exposure is made.

Above the side cabinets are specially designed projection lamps which provide perfect lighting of the features.

Many poses may be assumed before the newest "self-portrait" camera

"ALL WET"

PURE water is essential to health. Seventy percent of body weight is water, the lens of the eye contains 98.7 percent, the lungs 79 percent, the heart 79.5 percent, the blood 80 percent, our bones 25 to 50 percent—even our brains contain 90 percent water!

"Radium Hen" Detects Lost Radioactive Material

ACCORDING to a *Science Service* note, the "radium hen" comes from London and was described to American physicians and hospital workers by the London correspondent of the *Journal of the American Medical Association.* The hen is really an instrument developed in the National Physical Laboratory in England. It gets its name from the clucking sound it makes when placed near radium. The nearer it approaches the valuable element, the more rapidly and excitedly it clucks.

Hospitals occasionally, in spite of extreme care, lose or mislay radium "seeds," the tiny gold needle-like containers inserted in the body in cancer therapy. Every now and then one gets washed down the sink. Water can be poured down the sink and then tested for radioactivity, usually with negative results. Traps may be taken out and examined, but still the radium needle frequently goes undetected. Now all a hospital needs to do is to bring in the "radium hen." It leads quickly to the point in the pipe where the needle is lodged.

A letter addressed by the editor to the National Physical Laboratory mentioned above (an institution which occupies much the same position in Great Britain as the National Bureau of Standards in the United States) brings the accompanying photograph and the comment that the apparatus

The glow lamp and other essential components of the "radium hen"

"is essentially a simple and robust form of Geiger counter." (The Geiger counter was described in the September SCIENTIFIC AMERICAN, page 133.) The British laboratory continues as follows: "The ionization chamber consists of an ordinary neon glow-lamp, enclosed in a light-tight container, and supplied with a voltage just lower than that at which the discharge normally commences. In the presence of ionizing radiations the discharge voltage of such a lamp is somewhat lower than normal, so that the lamp glows more readily near a source of ionizing radiation. The operating voltage is supplied by a condenser charged through a suitable resistance by means of a dry battery, with the result that when the lamp glows the exciting voltage falls and the glow is extinguished. A pair of head telephones in series with the lamp thus records each discharge as a discrete click. In use, the possible locations of the missing radium container are explored and the presence of the radium is revealed by a rapid increase in the rate of clicking.

"The construction of the apparatus is shown in the photograph. The box contains the necessary batteries, while in the lid are mounted the condenser and resistances. The glow-lamp itself is mounted on a long handle suitable for exploring in corners and connected to the rest of the apparatus by means of shielded cables."

Non-Tarnishing Metal Fabrics

A NEW material, making possible non-tarnishable metallic fabrics, is made of metallized slit cellulose film, and is manufactured by depositing a metallic finish on one side of a sheet of Cellophane. Two such sheets are then laminated together, so that each side is metallic coated, and added strength is given to the stock. This sheet is then slit to narrow yarn widths,

which then may be woven into a fabric with rayon, silk, wool, or cotton. This material is the latest contribution of the chemical industry to the textile world. It is claimed for it that it will not tarnish or oxidize, thus solving a problem which has always proved difficult in the production of metallic textiles, of which there has been such a great vogue recently.

The new material was designed primarily for decorative use but its adaptation to other purposes has been so satisfactory that it is being employed also in the fashion field. The fabric is light in weight, flexible, and drapes well. Various forms of it are possible, thus making it conform to current trends in women's fashions. For example, a simple flat weave can be made for evening wear and a closely woven weave has been introduced for evening bags and footwear.

After many tests, it has been found to have a place also in the industrial field. It is adaptable to commercial methods of decorating such as lithographing, silk screen stenciling, embossing, corrugating, creping, shredding and other methods of decoration. —*A. E. B.*

Fast Airplane Tested for Navy

FLOWN by Paul S. Baker, the first of 84 new scout-bomber airplanes under construction for the Navy by Chance Vought Aircraft took off from Rentschler Field recently on its maiden test flight, under the watchful eyes of Vought executives and Navy inspectors.

Developed as a result of three years of design and testing in close co-operation with the Bureau of Aeronautics, the new type is expected to show higher performance characteristics than have previously been achieved by service types of airplanes of this class. It is a two seater biplane, designed to meet the limitations in size and landing speed imposed by the relatively small decks of the Navy's aircraft carriers, and is intended both for bombing and long-range scouting activities, which until now have been performed by two distinct types of airplanes.

The new airplane, designated as Model SBU-1, represents a distinct departure in many respects from the well-known Vought Corsair type which for many years has been in wide use on the aircraft carriers, battleships, and cruisers of the United States Fleet. Its structure is composed of metal, with fabric covering except for the fixed tail surfaces, which are metal-covered. Detailed description and performance data may not be released, but Vought officials said the results of the first tests were "entirely satisfactory".

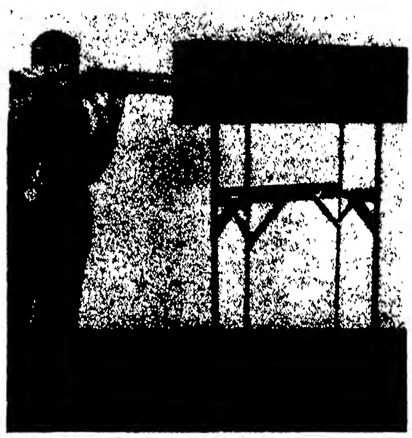
The new combined bombing and long-range scouting airplane described above

HONEY AND GASOLINE

GASOLINE cost enters into the cost of producing honey, strange as it may seem. This is due to the fact that about 10 percent of the cost of a pound of honey is in the transportation of the honey itself and also of hives which frequently must be moved from place to place.

Target Range Mufflers

IN the Museum of Science and Industry, New York City, one exhibit shows the sound deadening qualities of certain felted materials. Two small tunnels, both made of wood and about six feet long, have at their opposite ends tiny bells. One is unlined while the other is lined with felt. When a button is pushed to ring the bell behind the unlined one, the metallic clang sounds very sharp to the ears. When the bell behind the lined tunnel is rung, a very subdued muffled tone emanates from the open end.



Muffling the sound of rifle fire

This principle has now been adapted to a muffler for use on target ranges, particularly those indoors where the noise of rifle or pistol shots is very disturbing to the shooter as well as to spectators. These have been produced by the Burgess Battery Company, Acoustic Division, and are shown in the accompanying illustrations.

A cut-away view of the pistol muffler, and a close-up of the walls

The inner walls of both the rifle and the pistol mufflers are perforated sheet metal with balsam wool between the perforated metal and the sheet metal outer walls. The principle of operation is based on the remarkable absorption of sound by the wool, the principle of which is shown in the exhibit mentioned above. As the mufflers have no connection with the gun, their use is not prohibited by the laws against gun silencers. The only noise heard when a gun is fired is a dull thump. One particular advantage is that these mufflers permit complete lighting of indoor target ranges because the front sights of guns are so covered in firing that there is no reflected glare to disturb the aim.

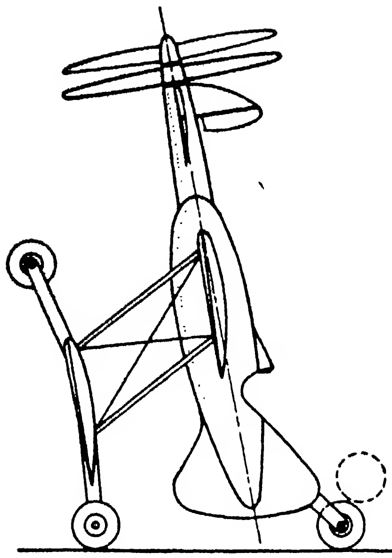
Protective Paint for Metals

A PAINT process developed by the Harrington Paint Co., Inc., is claimed to transform rust on metal surfaces into a light-proof color body of high weather-alkali-acid resistance. Instead of requiring hours of labor for its removal, the rusted surface becomes an essential part of the protective coating. The paint is made on a Tornesit (chlorinated rubber) base which in itself shows approximately 99 percent proof against moisture penetration and provides a non-inflammable and tough film with great adhesive powers. It is reported to have a rapid drying rate, ease of application, and long life under adverse conditions. *A. E. B*

An Airship Conference

FRIENDS of the large rigid airship have not lost hope. The Airship Survey Committee is hard at work and will in time produce a broad fundamental study of the problems of the airship. At the Daniel Guggenheim Airship Institute, the recent forum on lighter-than-air craft was well attended by a number of specialists, and valuable papers were read. These papers were so highly technical in character that only the briefest review is possible.

Airships are complex structures and very difficult to analyze mathematically. But by observing certain laws of dynamic similarity, it is possible to construct small models from which the behaviour of the full-size airship under load can be accurately predicted. One such model method employs



Above and right: **Two types of orthoplanes suggested by Dr. A. F. Zahm, and described on this page**

wires to represent the complex girders of the actual machine.

A strong plea was made at the forum for the metalclad airship, as being stronger, more resistant to weather, and less wasteful of helium gas than the conventional fabric covered airship. This plea was all the more timely because the only metalclad airship ever built, the *ZMC-2*, has just completed its sixth year of consecutive service, with Lakehurst as its base. It is in splendid shape, with not a single serious mishap to mar its record.

We have become accustomed to one main type of airship, comprising a hull, with longitudinal girders, transverse frames, and transverse wiring; with the propellers mounted at the side of the airship, along the side, and so on. At the forum were discussed a number of interesting possibilities departing from the conventional. Thus in the Respess airship, a suspension bridge construction is proposed, in which a rigid center beam would be embodied, with cables replacing the rigid framework. Lighter structure and lesser maintenance charges are claimed for this novel design. Automatic control has been utilized quite largely and successfully for the airplane. Why not automatic control for the airship where the pilot's problems are even more complex? The control surfaces of an airship are always placed at the tail. Why not place control surfaces at the bow—either at the bow alone or in conjunction with tail surfaces? Actuation of the controls might then be accompanied by less vertical displacement.

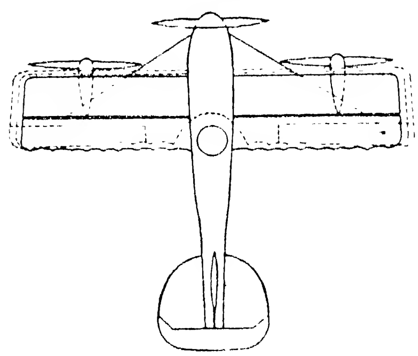
Dynamic lift is that part of the lift which is produced by the reaction of the air on the moving hull as distinct from the aerostatic lift of the gas cells. It was pointed out that the possibilities of dynamic lift have not been fully exhausted. Another suggestion was that the airship should be provided with a large central passage, and the propellers placed inside this passage. Boundary layer control was mentioned, with suitable ejection or suction of air through the outer covering to diminish the drag. Boundary layer control has been investigated in regard to airfoils but such control might be much more effective in the airship.

All this indicates that the airship people have not given up the good fight, and that hitherto unexplored avenues of research still remain in this field.—*A. K.*

Orthoplanes

Dr. A. F. Zahm, of the Library of Congress, one of the most distinguished American aerodynamicists, has sent us an interesting note on a suggested type of aircraft which he terms "orthoplanes." The orthoplane is an airplane designed to fly straight up from rest, with all control surfaces in the slipstream.

"Given adequate blast, such controls can function in any flight attitude, at all flight speeds, and at no speed," writes Dr. Zahm. "Suitably proportioned, the controls would obviate stalling and spinning dangers, for



in the strong wash they could overcome the auto-rolling urge of the wings. Three slipstreams indeed are not essential, as all the surfaces can be placed in one or two streams. Now suppose each motor is a Pegasus X air-cooled engine weighing about 1000 pounds and easily supplying 800 horsepower to an airscrew of small diameter, say one giving a static thrust of three pounds per horsepower. The three engines total 2400 horsepower, weight 3000 pounds, and exert 7200 pounds thrust. This can lift vertically the engines and a loaded airplane weighing 3000 extra pounds, and still leave 1200 pounds excess thrust for swift vertical climb. Throttling the power a pilot could hover, or descend at moderate speed, tail downward; leveling off he could sweep forward at very great speed with a thrust initially exceeding the whole 6000 pounds weight of plane and engines combined. The craft shown could take off and land in the usual way. Because of its large propeller race, covering most of the wing surface, it would hover with its axis far from vertical.

"Another type of orthoplane can stand upright and function as a helicopter, besides taking off and landing as an ordinary plane. It should be a useful scout for rough terrain; and enable light burdens to hop from a roof in one city to a roof in a neighboring city in much less time than by usual transport planes starting from suburban airports."

Besides making these interesting suggestions, Dr. Zahm very rightly insists on the desirability of a world-wide competition for direct-lift aircraft. Such a competition would undoubtedly excite the greatest interest.—*A. K.*

What is the Power of an Engine?

We have been accustomed in these columns to mention a given engine as having such and such a power at a given revolutions per minute. As the art progresses, engine ratings have to be given more explicit definitions. In fact, there are now three different kinds of ratings applicable to any one motor, as follows:

1. *The take-off rating.* The maximum permissible power output at low altitudes to which an engine may be pushed for a few minutes.

2. *The maximum power for protracted periods.* This is the maximum power which may be used to reach destination in the event of an emergency.

3. *Cruising rating.* This is the maximum power which may be safely used for continuous, normal operation.

The Department of Commerce is making a thorough study of the problem and will certainly issue new regulations, defining the various ratings of all existing engines in this manner.

As an example, we will give the ratings adopted by United Aircraft Corporation for one of its Wasp models.

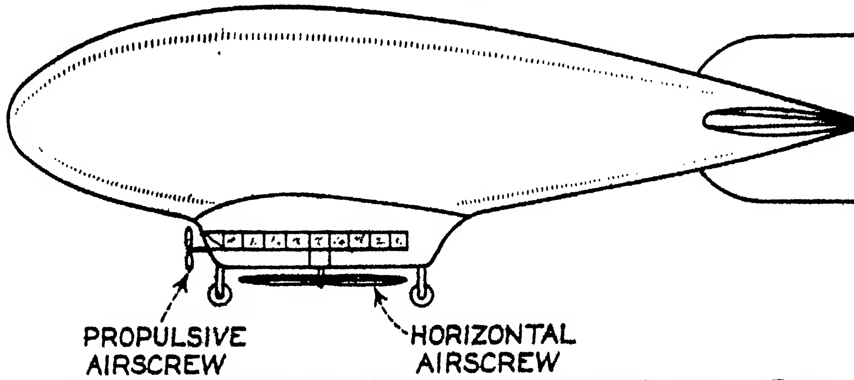
1. Power allowable for take-off, 450 horsepower at 2300 revolutions per minute.

2. Cruising power for continuous emergency operation, 300 horsepower at 2000 revolutions per minute at 9600 feet altitude.

3. Maximum power for continuous emergency operation, 400 horsepower at 2200 revolutions per minute.—*A. K.*

Airship plus Helicopter

The veteran French balloonist Toussus-le-Noble has successfully demonstrated at a flying field near Paris, a small dirigible which is really an airship in combination with a helicopter. The peculiar craft is illustrated in one of our sketches. In addition to the ordinary hull and suspended gondola, and a 60 horsepower engine driving a propulsive airscrew, an auxiliary 12



A type of airship-helicopter that has undergone successful tests in France

horsepower engine is provided which drives a horizontal airscrew.

The new aircraft has been dubbed a helicostat. It is slightly heavier-than-air; that is, the gross weight of the craft is greater than the lifting capacity of the gas bags. By operating the horizontal airscrew, the craft can rise or descend vertically. At first the horizontal airscrew lifts the craft vertically upwards. Then the lifting airscrew is stopped and the forward engine gives the dirigible a speed of 40 miles per hour.

It may be objected that precisely the same thing can be achieved with the use of ballast. But the provision of the lifting airscrew eliminates the use of ballast and renders the operation of rising, hovering, or descending much less delicate.—*A. K.*

AIRCRAFT PRODUCTION

IN the first six months of 1935, 851 airplanes were produced in the United States, a 14 percent increase over the corresponding period in 1934. These new planes include 517 for domestic civil use, 173 for military purposes, and 161 for export.

A Huge Bomber

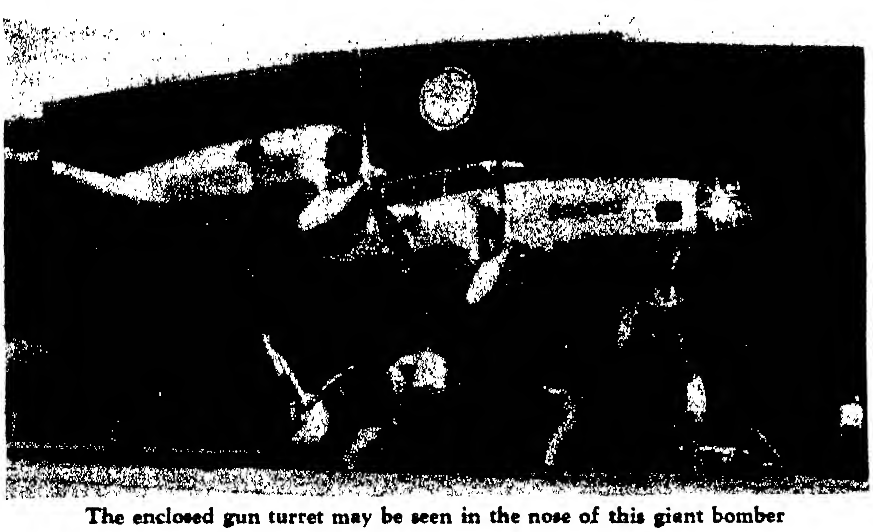
EUROPEAN countries are arming frantically and certainly are not neglecting aircraft. In fact, certain American experts on returning from over-seas have recently spoken of supremacy in military aviation passing from the United States. The construction of such airplanes as the new Boeing bomber is reassuring in this regard. The Boeing 299, which weighs over 15 tons, has a wing span of approximately 100 feet, an over-all length of 70 feet, and a height of 15 feet. It is of the all-metal mid-wing type, and is equipped with four Hornet engines of over 700 horsepower each. A three-bladed variable pitch propeller is employed, built by Hamilton-Standard. The streamlining is excellent and the landing gear and tail wheel are both retractible.

The bomber, at the time of writing, is undergoing trials at Wright Field, Dayton, Ohio, in competition with other designs. The system of procurement employed by the Army is curious. Constructors submit design bids in line with a specification issued by the Army. A small number are awarded experimental contracts. But these contracts merely mean that the manufacturers are privileged to present models for the competition at their own risk, and may never receive a penny for their best efforts. Thus, bidding for Army contracts on new types is a speculation of the wildest possible sort. Since hundreds of thousands of dollars are involved, we should imagine that in no other business is so much cool-headed gambling required of the executives.

New Boeing bombing plane ready to take off

The 299 has already made a world's record for sustained speed, flying 2300 miles in exactly nine hours, at an average speed of 255 miles an hour!

The 1931 Boeing twin-engine bomber was the forerunner of the twin-engined Boeing transport, and well-informed gossip has it that the new four-engined plane will also serve to introduce a large transport. The continuous and rapid growth in the passengers, mail, and express carried on American airlines also serves to confirm a rumor that a larger Douglas commercial transport will soon appear on the scene. At present our airliners do not pay even when flying loaded almost to capacity. If 32 passengers could be carried instead of 16, with the same flying personnel and practically the same ground crew and ground organization, the possibilities of profitable operation would undoubtedly be much brighter.—*A. K.*



The enclosed gun turret may be seen in the nose of this giant bomber

Helium in Sweden

A NEW source of helium has been found on Osland Island along the east coast of Sweden, according to *Industrial and Engineering Chemistry*, publication of the American Chemical Society. Natural gas containing 1.4 percent helium has been tapped. Other borings on Gotland, a neighboring island, are expected to yield petroleum as well as appreciable amounts of helium, the Scandinavian correspondent says.

Air Transport Statistics

THE scheduled operations of American air transport lines are showing remarkable growth. The following figures for the first six months of three years are so striking as scarcely to need comment:

	1933	1934	1935
Passengers	229,075	223,381	367,357
Passenger Miles	73,288,579	88,055,113	160,013,357
Percent of scheduled miles flown	92.4%	91.2%	90.5%

Each month this year shows an increase in activity over the preceding month and over the corresponding month of 1934. Now that both the House and the Senate have passed a bill which will allow the I.C.C. to raise the airmail rates, better times are definitely in sight for the operators!—*A. K.*

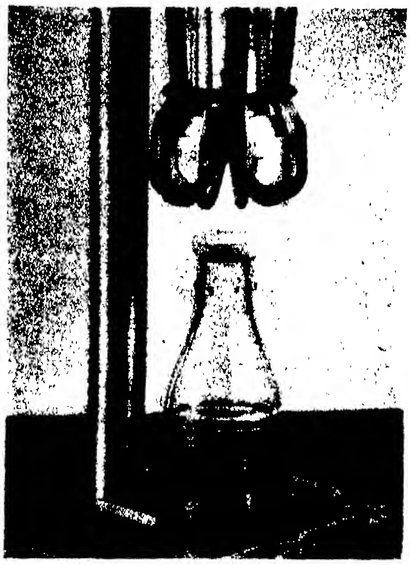
Air War over London

THE Society of British Aircraft Constructors has given a reliable account of the recent air "war" over London, in which 365 airplanes flew some 400,000 miles. It appears that this air war is an annual affair, with the testing of London's defenses as its special purpose.

The incoming raiders flew at greater heights than in previous years—over 19,500 feet—and the bombing formations flew through clouds with the aid of blind flying instruments. This made the task of the defenders still more difficult, since they had to depend largely on listening apparatus to locate the enemy. Some of the bombers proved to be almost inaudible on the ground when flying at an altitude of 15,000 feet.

The defenders were adjudged to have inflicted serious losses on the bombers, but on the other hand the attacking fleet had many of its units passing the defensive network, and a light bombing squadron operating on the outskirts of London made three dive bombing attacks and scored 80 to 85 percent of hits. This accuracy is far greater than that of the most accurate gunfire.

Air Marshal Sir Robert Brooke-Popham declared significantly: "This year's exercise has shown up the difficulties which may be expected in conducting defense against more silent aircraft, flying at even greater altitudes."



Flexible milk bottle caps may be applied by hand or automatically

British opinion is that the only real defense against bombing raids is in counterattacks on the enemy's military objectives, which may be expected to prevent the departure of his bombers. This is a paraphrase on the old saying "Attack is the best defense." The best protection of our seaboards against air attacks from an enemy fleet would be in the form of destructive bombing forays against such a fleet. This is a moral which the United States would do well to take to heart.—*A. K.*

Illuminator for Star Charts

AMATEUR astronomers often find it difficult to provide for the practical use of charts of the heavens when out of doors at night at the eyepiece of their telescopes. If a strong light is used to see the charts, the eye at once loses its observing sensitivity for immediate use of the telescope. James S. Andrews of Rutherford, New Jersey, a well known variable star observer, tried placing his charts on a glass covered box, and illuminated them very faintly from below. This proved to be so practicable that he refined the same apparatus into a finished device, as shown in an accompanying photograph.

The lamps are controlled by rheostat and, by dimming them to minimum chart visibility, the pupil of the eye is not caused to contract unduly as would be the case with a strong light. Mr. Andrews has also put a flap-covered tunnel in the end of the box, for storage of rolled charts. His batteries are hidden between the box and sloping reflector, although 110-volt current may be extended to the same device.

To an amateur astronomer the picture otherwise explains itself. The star charts are ordinary blueprints and are 8 by 10½ inches in dimensions.

New Milk Bottle Hood

AN unusual coverall milk bottle hood made of a pliable composition material which has sufficient resiliency to allow it to be stretched over the top of a milk bottle, is stiff enough to cling to the bottle and not come off under the type of usage to which the bottles are subjected.

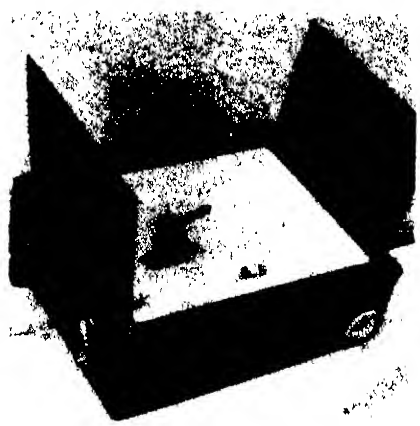
Being always under tension on the top of the bottle, the new cap is always a perfect seal and will not loosen as a result of a jar or bump. It also has the advantage of not being pushed off the top of the bottle if the milk is allowed to freeze in cold weather.

The inventor, John R. Gammeter, has designed capping and printing machinery for the hoods. A hand capping machine for the small dairy will place the hoods on the bottles at the rate of 20 to 30 per minute. Automatic capping machines for larger dairies may be placed in the filling lines at practically no extra cost.

Lighting a Windowless Building

SOME interesting lighting problems have been solved in connection with the interior illumination of a completely air-conditioned office building of the Hershey Chocolate Corporation. It was found that, with completely artificial lighting, a better effect can be had than with a combination of daylight and artificial lighting or wholly daylight, because of the wide variations in the intensity of daylight.

There will be maintained at the working



Rolled charts may be kept in the end of the star-chart illuminator

level on the desks an intensity of 20 foot-candles, which is considered good practice for office work. The lighting will be almost completely indirect, using a combination fixture which contains both mercury vapor and Mazda lighting. The reason for this is that incandescent lights give little of the violet and blue whereas the mercury vapor lighting is weak in the orange and red part of the spectrum but strong in the violet and blue. A combination of the two within the same fixture approaches daylight and gives a far better effect than any single source. Within each fixture there is one 750-watt Mazda lamp and one 300-watt mercury vapor, making a total of 1050 watts per fixture.

Should the source of current fail while the employees are at work, an automatic throw-over switch will re-establish electric current from an entirely separate source. The second source of supply will also provide energy for the operation of the motors driving the ventilating fans of the air conditioning system so that the supply of air will not cease even though the first source should be inoperative.

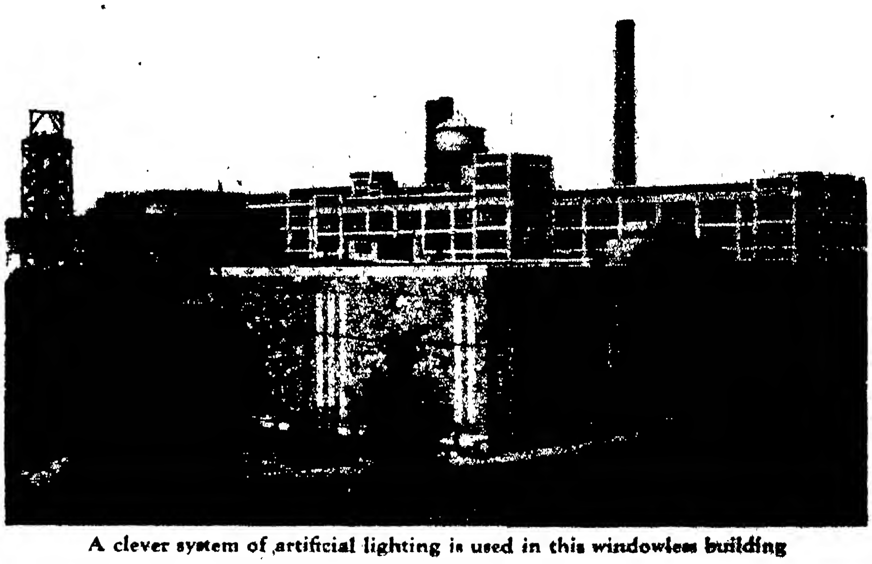
SNAKE AGE

FOR two reasons the number of rattles carried by a rattlesnake do not tell its age, contrary to general opinion. One is that the rattle is brittle and segments occasionally break off. The other is that a new button is exposed each time the snake sheds and this process is repeated from two to seven times a year.

More Soap

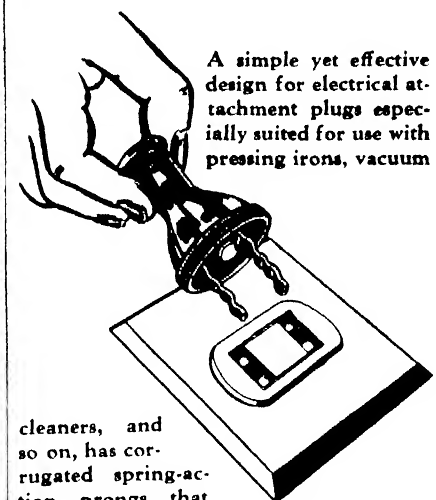
FIRM in the belief that "cleanliness is next to Godliness," the American public continues to raise its per capita consumption of soap at an amazing rate—we now use 100 cakes per year per person as against five in the Soviet Republics—and backed by one of the most intensive advertising campaigns of any American industry, that rate is accelerating tremendously.

The increased consumption of fatty oils in all groups has been remarkable. Comparative figures for 1914 and 1929, compiled by *Chemical Industries*, show an increase in all uses of the oils of the food and soap group from about 2,350,000,000 pounds in 1914 to 4,025,000,000 pounds in 1929, a gain of 71 percent. In the same period the population increased but 25



A clever system of artificial lighting is used in this windowless building

percent. Again, excluding lard, foreign oils represented 10 percent of the total consumption in 1914, whereas by 1929 imports had risen to 30 percent of the total. Nor did the consumption of oils decline as sharply in the depression years from 1930 to 1935 as did most other commodities. In 1934 total factory consumption excluding lard ran over four billion pounds.—*A. E. B.*



A simple yet effective design for electrical attachment plugs especially suited for use with pressing irons, vacuum cleaners, and so on, has corrugated spring-action prongs that make good electrical contact yet grip so firmly that it is almost impossible for the plug to loosen accidentally

BEES

THE photograph of a swarm of bees appearing on page 126 of our September number should have been credited to Edward F. Bigelow, ArcAdiA, Old Greenwich, Connecticut.

WARNING AGAINST DINITROPHENOL

BLINDNESS from the use of dinitrophenol for reducing weight has not stopped the use of the drug in spite of repeated warning, says W. G. Campbell, Chief of the Federal Food and Drug Administration. The eye cataracts observed in dinitrophenol poisoning develop with a rapidity and malignancy hitherto unknown, and result in total blindness within a comparatively short time. This drug may produce acute poisoning, the symptoms of which are nausea, stomach and intestinal distress, sweating, flushed skin, high fever, rapid breathing, and muscular rigor followed by death. The drug also damages the liver, kidneys, heart and sensory nerves. It produces agranulocytosis, a blood disorder also noted in cases of poisoning with amidopyrine, a common ingredient of medicines for the relief of pain.

The Food and Drugs Act, according to Mr. Campbell, is practically inoperative against this public health hazard. He says, "The only application of the law to these products is through some misstatement of fact or some false and fraudulent curative claim in the labeling. In any event, the law can be invoked only when the product has been transported across a state line."

Of all the products containing dinitrophenol now on the market, only one has been confiscated under the Food and Drugs Act, the Administration reports. That was

"Slim," against which legal action was brought because of a label claim that it was "safe to use," whereas medical opinion is unanimous to the contrary. Dinitrophenol is sold under many fanciful names sometimes accompanied by a statement of the presence of the drug itself. Some of the names under which it has been or is now being sold are reported by the Food and Drug Administration as follows: Nitromot, Dinitrolac, Nitra-Phon, Dinitriso, Formula 281, Dinitrose, Nox-Ben-Ol, Re-Du, Aldinol, Dinitrenal, Prescription No. 17, Slim, Dinitrole, Tabolin and Redusols.

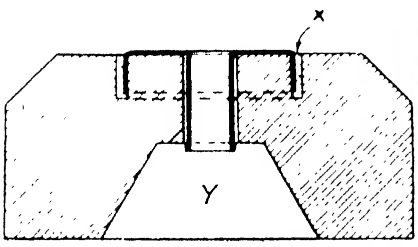
"It is interesting to note," said Mr. Campbell, "that all the so-called reducing preparations on the market fall into three categories: first, laxatives that deny the body the benefit of its food intake, as the salts, crystals, and herb teas; second, obvious frauds that depend for effect upon the stringent diets prescribed as part of the 'treatment', as 'Syl-Vetto' and 'Stardom's Hollywood Diet'; and third, the unquestionably effective but dangerous articles containing thyroid or dinitrophenol, both of which act by speeding up the utilization of food. All of them are unwarranted impositions upon the public, which cannot evaluate claims made for the preparations, and cannot readily appreciate the harm that may result from careless use of the products."

Alloy Orifice Gives Uniform Glass Flow

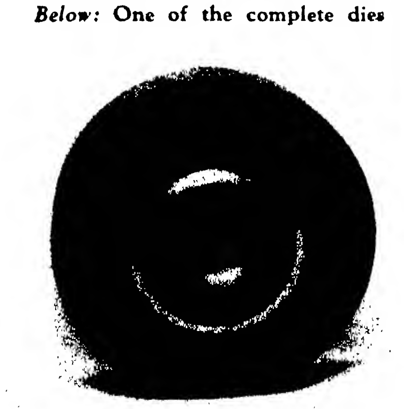
DEVELOPMENT of a refractory die with an alloy lining has made it possible to obtain a uniform flow of glass when filling electric lamp bases and has brought to Henry K. Richardson and Frank A. Newcombe an "Award for the Outstanding Accomplishment" of the Westinghouse Lamp Company.

The alloy lining has increased the life of dies by 190 times and production from 7 to 15 percent. Uniform glass flow has in turn permitted the adoption of automatic temperature control for oil burners on the glass furnaces.

Black insulating glass in the bases of



Above: **Section of new alloy-lined refractory die described in text.** ***Below:*** **One of the complete dies**



incandescent lamps is delivered to the basing machine from a tank so small that no stack is required. A positive pressure is always present in the furnace. An oil burner, acting both as a melting and delivery burner, fires the tank from one side. The batch is changed intermittently every 20 minutes.

At a speed of 220 per minute, the brass shells of medium screw bases, such as those on general household lamps, are indexed automatically into the glass stream flowing through an orifice in the bottom of the furnace. In this fraction of a second, an exact amount of glass must fall into each base. Hence the temperature, diameter, and speed of flow of the glass stream must remain within close limits to assure uniform production.

In the past, the porcelain die would erode within a few hours, making it difficult to maintain a uniform stream. Glass delivery had to be adjusted at frequent intervals by changing the temperature in the furnace or by doctoring the batch with sand or soda. Sooner or later the glass composition became unstable and fractured glass frequently occurred.

Finally the operation had to be stopped altogether to allow for a complete new start. By the time 200,000 bases were filled (15 hours at the most) a new plug or an entire new die had to be installed. The time for these adjustments slowed production, introduced considerable wastage, and in general contributed to high manufacturing costs.

With the new alloy-lined die, these difficulties have been minimized until they are now negligible factors. Uniform flow of glass and automatic temperature control make it possible to fill approximately 38,000,000 bases without a die change.

After numerous tests with high-temperature alloy metals and various refractory compositions, none of which proved better than porcelain, an alloy of 90 percent platinum and 10 percent rhodium was found best in resisting the abrasive action of the hot flowing glass. A lining of this alloy, 0.030 inches thick, is inserted into an Alundum refractory support to form the die now in general use.

BUBBLES FOR CEMENT

THE "bottle of bubbles" flotation process which worked such wonders in the separation of metals in western mining, has now been applied to cement materials, reports *Chemical and Metallurgical Engineering*, and is again working wonders. By putting the raw rock through the bubbles, desirable elements are floated out—and in most cases a single type of rock, treated this way, can be made to yield material for every type of cement.—*A. E. B.*

BONES MADE "RUBBERY" TO CORRECT DEFORMITIES

GIVING crippled patients "rubbery" bones and then bending the deformities straight is the new technique described before the Fifteenth International Physiological Congress in Leningrad, by Dr. I. William Nachlas of the Johns Hopkins University Hospital, Baltimore.

In collaboration with Dr. David Shelling, Dr. Nachlas has worked out a diet and routine of internal medication which softens skeletal structures.

"This change of the bone to a more or

less rubbery structure will permit the manual correction of deformities for which surgical treatment is either undesirable or impossible," Dr. Nachlas explained. "The straightened limbs are then held in position by a cast or other form of support while the bones are rehardened."—*Science Service.*

FAST COLOR MOLDING PLASTIC

MOLDED plastic parts exposed to acetone and other strong solvents or acids sometimes are subject to bleeding of the dye, and to overcome this General Plastics, Inc. has recently brought out a non-bleeding material called "3973 Black." Although originally developed to overcome the bleeding troubles in molded bottle caps in contact with strong solutions, the new material has found many industrial applications. With a low-moisture absorption rate of 0.7 percent, "Durez 3973" has a rich, high gloss finish and high torsional strength, and is recommended for textile machinery parts where any bleeding of the dye under the action of solvents would prove troublesome. It has a compressive strength of 30,000 pounds per square inch. *A. E. B.*

SEVERE VITAMIN LACK CAUSES BREAKDOWN OF NERVES

VITAMIN lack in the diet, if severe enough, causes an actual breakdown and "death" of nerve tissue, experiments on rats by Dr. Charles Davison, of Montefiore Hospital, New York City, have demonstrated. In the experiments, rats were fed diets adequate to sustain life, except that each diet wholly lacked one or another of the vitamins, from A to E. The animals became ill, finally losing the use of one or both of their hind limbs.

When they were chloroformed and dissected, it was found that the nerves leading to their muscles were abnormal in appearance and structure, with an actual breakdown of the nerve substance itself, and in some cases brain hemorrhage. *Science Service.*

ENGINEERING INDEX PREDICTS GREAT PROGRESS

THAT especially far-reaching developments are about to be made in the fields of television, mining, power plant equipment, aviation, and automobiles is indicated by a barometric reading of the Annual Volume for the fiftieth year of the Engineering Index.

This complete assembled record of engineering advancement in all its branches in all parts of the world for the last year contains 1320 pages, describes engineering items in 2000 different publications, lists 40,000 separate items of periodical literature under 5000 various subject headings, and cites 25,000 separate authors who wrote in 40 different countries and in 20 different languages.

The whole story of American industry, of course, cannot be read between the lines of the Engineering Index. In addition to the trends which the Index points out, there

(*Please turn to page 279*)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

AMATEUR telescope makers and astronomers who regularly read this department and who enjoy organizing societies will derive practical pointers based on actual experience from a short article published below, on "Organizing an Amateur Astronomy Club," written by Leo J. Scanlon at our request—or rather in order to provide an answer to the requests of numerous readers who have at various times asked us how to organize a club of this kind. Scanlon has had good success at organizing and is enterprising. His energies and those of his club group burn steadily and through several years they have not petered out. Some amateur clubs in the past have been a little more like novæ or new stars: They blaze forth, shine brilliantly for a time and then decline to a lower candle power. They doubtlessly start too auspiciously, and the more gaseous parts of the nova soon pass off into the circumambient ether, or are exhausted by direct conversion into brilliant radiation. New clubs also fall, sometimes, into the clutches of those who would make the organization an end in itself (one we knew of had about nine vice-presidents), and who insist on regimenting everybody to such an extent that it is more fun to go home and play telescope by one's self and not be ordered around all the time. In these things there is a happy medium and such, we reckon, is what Scanlon, no flickering, fluctuating nova but just one of the steady stars of the firmament, outlines as follows:

"WHEN two amateur telescope makers get their heads together over a polishing barrel--a group is started. When two friends meet on a warm summer night, and their thoughts turn to the moon and stars—a group is started. In either case, it's merely a matter of securing the companionship of others of like interest—which is the point we shall now discuss. It will be our aim, in organizing this group, to help others to enjoy the many pleasurable hours we have spent tracing out the constellations upon the deep blue of the night sky, or to have them feel the peculiar satisfaction of having achieved a telescope mirror that will show them more clearly the myriad wonders of the universe of stars. We shall have a secondary pleasure in watching others succumb to the insidious addiction of which we have experienced, grinding glass with Carbo, and painting the household with rouge.

"If you have made a telescope, or purchased one, you are the logical one to start the organization. If you built your own telescope, the local newspaper would be more than willing to publish a photograph of it, with a description of your harrowing experiences in grinding, polishing, regrinding and so on. The sensitivity of the knife-edge test is always amazing to the uninitiated, and is often the one thing about making a telescope that awakens an interest which is never satisfied until the witness has performed it repeatedly on a mirror of his own making.

"If you have no telescope, write for your local newspaper short articles on objects of interest in the sky at different times, concentrating attention on a particular object, describing it in the detail that is at your command. These articles should appear more or less regularly. Soon others will seek you out and declare their interest in the same subject.

"Go to your library, and see who has been reading the astronomical books. Contact them by mail, avow your interest in the same subject, and it's an easy bet that you and your opposite get together. Answer all correspondence promptly, even if it hurts.

"Don't hide your light under a bushel. If you want to have the benefit of the experience, assistance, and personality of others, you must let them know where you are. If they're at all interested, they will get in touch with you.

"Business houses are usually willing to permit a group to set up a display of your workmanship in their show windows; it is good advertising for both of you.

"When you have secured the names and addresses of a dozen persons in your locality who are interested in astronomy or telescope making, call a meeting at the home of one of them. Have someone elected by acclamation to conduct the meeting. He will be known as President, Chairman, or what-not—but as yet the group will not have a name. Do not attempt at this time to name it—a name will gradually suggest itself. When you do find it necessary to identify yourselves, make the name as concise as possible—or it will take up too much room on your meeting notices. [We forgot to mention that Mr. Scanlon's organization is known as the 'Astronomical Section of the Academy of Science and Art of Pittsburgh.'—*Ed.*] Have a rubber stamp made with the name on it—and give it to the Secretary.

"Meet regularly, regardless of how few attend. Remember that the best organization is not necessarily a large one. Only one person out of a thousand will be interested in your subject, and that is a high percentage.

"Make the meetings informal; don't read any minutes during the first year. Report on activity of different members; talk about latest developments in astronomy.

"Get a standard astronomy textbook, and let each member take a particular chapter in turn and explain all about it, to the best of his ability—then discuss it.

"Buy, borrow, or rent lantern slide or motion picture lectures on astronomy. Large corporations often have them for free showing; lectures can be rented from observatories for a nominal charge.

"The major activities of the group will be building and using telescopes; the telescope building will progress almost unaided after someone makes a start.

"Since it is the aim of the telescope builder to supply himself with a 'scope at low cost, using the instrument upon completion is a foregone conclusion. However, undirected observation of the skies tends to become monotonous unless one has the proper guides, such as sky maps, handbooks, and so on. It should be the duty of the Secretary to post himself upon all such publications and secure them for members of the group.

"One of the first activities of the group should be to conduct a class in elementary astronomy. There will be no difficulty in securing a standard text on astronomy, and having each member study and present to one of the meetings a selected chapter from the book. A half hour of each meeting period could be thus profitably spent.

"Start a lending library among your members. Loan each other scientific books, taking a receipt for them, and receive a promise of their return within a reasonable time. Return promptly all books you borrow.

"Photograph the constellations, moon, and planets with your own modest equipment. There are books available dealing with this subject; get them through your

Part of a note by R. W. P., prompted by a reader's suggestion for a patent dingbat to facilitate adjusting a testing stand from the knife-edge end. As stated on it, R. W. P. had not tried this when he wrote the note several years ago. Who will be "it"?

group library. Have the photographically inclined member do the developing and printing of the plates, and make lantern slides from them. Give informal lectures with these and other slides secured elsewhere to churches, clubs, and groups, gratis.

"Start a club scrap book. Keep photographs of the activity of the various members; clippings from newspapers and journals dealing with your hobby; photographs contributed by other amateurs or

What happens when an attempt is made to photograph the moon without a clock drive and with a five-second exposure—a blur. Submitted by E. T. K., of Marshalltown, Iowa

groups. Co-operate with other groups in exchanging information, ideas, and materials.

"Those without equipment may be interested in studying meteors. This field is still new and open to anyone.

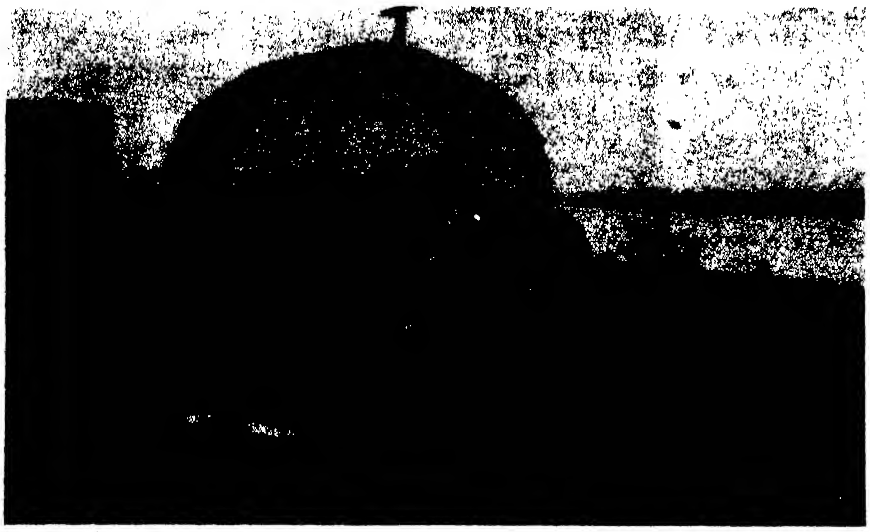
"Someone with the zeal to do 'real scientific work' will want to observe variable stars. This is one work that always offers the possibility of a thrilling discovery and sudden fame—the discovery of a comet or a nova is frequent enough to be encouraging.

"Arrange visits to local points of interest; visit newspaper plants, industrial concerns using science in their business; arrange at least one visit each year to some observatory where you will have unrestricted use of a telescope of considerable power, under the direction of a sympathetic astronomer.

"Take advantage of the various talents to be found in your own group; have the mathematical shark compute an orbit or explain the movements of the planets; have the draughtsman design your mountings; have the chemist lecture on the intricacy of the silvering process; have the photographer explain celestial photography; have the skilled mechanic devise better means of moving and holding your telescope. Interest your friends who are not members of the group in your hobby; they are usually willing to help you secure materials and service at less than usual cost.

"In summary: Consider yourself a committee of one to start the organization going. When you have gathered a few interested ones, co-operate with them in every way; give freely of your service.

"Don't urge anyone to join your group.



The Astrosonus Observatory and the reticle for use in meteor observing

If people do not have the desire to ally themselves with you without urging, they are not the ones you want; don't have a membership campaign build up your membership slowly and firmly.

"Make your membership requirements simple; be certain that the members are interested—be certain they are good fellows!

"Work as a group, for the interest of the group. Don't promise to do anything you can't; do more than you promise.

"Don't enjoy your hobby painfully; if you don't feel like observing on a cold night, don't do it because someone expects you to do it. If you don't feel like grinding your mirror, forget it for a few nights and read a book. Follow the hobby for the fun of it—be the master of your hobby, not its slave."

ORGANIZER Scanlon also wishes us to publish the announcement that there is to be another exhibit of amateur astronomers' work, in connection with the science exhibit at the annual convention of the American Association for the Advancement of Science, to be held this year at St. Louis, December 30 to January 4. All amateurs wishing to submit exhibits in the form of photographs, transparencies, or material made or used by amateurs, should communicate with him (Leo J. Scanlon) at Valley View Observatory, 106 Van Buren St., Pittsburgh, Pa. The exhibit he organized last year at the same association's meeting was a big success—a compact crowd filled the booth throughout; even Professor Einstein came.

THE spider web shown in the picture on this page is a reticle used by the amateurs at the "Astrosonus Observatory," and the picture was sent by Arthur DeVany and Bernhard Nordblum, Jr., 929 Grand Ave., Davenport, Iowa. These two state that the Midwest Meteor Society, of which Prof. C. C. Wylie of the Iowa State University at Iowa City is president, worked out this method for determining the height of meteors. The four converging rods join an open ring, the "eyepiece," and the meteor's path may be accurately read as is crosses various parts of the reticle. Two reticles, separated by 30 to 60 miles, make simultaneous readings, and the rest is a matter of triangulation. The observatory shown is near the banks of "Old Man River," and houses a 6-inch Clark. Another observatory dome near by houses a 10-inch reflector made by the group (Tri-Cities Astronomical Club), which also has on the site six cameras of wide aperture, a 115-foot sun telescope, and a comet finder. Meteor shooting is a kind of astronomer's skeet game, and said to be lots of fun.

EARLIER this year Russell Porter was ill and confined to home for about five months, but relatively few knew about it at that time. Then, just when he came on deck again and went to work, word got around that he was very ill—a sort of phase lag in news arrival. To lay the ghost of the rumor, we quote what he writes: "I am on the job now, all cylinders." Everybody will be glad to hear this. While in bed he wrote a long chapter on mountings, for the fourth edition of A. T. M.

IT seems a pity that no more spectrohelioscopes have been made. The total score is one—just one—made by Prescott of Wells River, Vermont. Someone in England made one, it is true, but did not tackle the tough part, the 13 optical surfaces, as the courageous, tenacious Henry B. did. Picking up the July number of the *Journal of the British Astronomical Association* (by the way, why don't more join this amateur society—every club should have at least one member in it, in order to get the *Journal* and pass it around) we find an article by F. J. Sellers, one of the mechanical group of British amateurs and the same Sellers whose chapter on a simple clock drive is in A. T. M., and read that the mean daily frequency of solar prominences during three recent months was 8.93, a lot to look at if one had a s'h'scope. He describes the 50,000-mile prominence of June 22-23, "a most remarkable prominence display. The outbreak was dense and brilliant, changing very rapidly." In the same number he describes a solar prominence spectroscope, with instructions for making and using it; a grating is attached to a 30-60-90 prism, and the dispersion is large.

MORE short, compact instructions for making setting circles, also for collimating different types of telescopes, are needed for the A. T. M. Supplement, as no one person seems to be able to write complete chapters on these subjects. We have some mighty fine material for this book, and more is promised. The latter ought to be sent in soon—we are working on this book every spare minute. Please don't ask us when it will appear, for we don't yet know. It will appear as soon as limitations of necessary sleep permit, and it will surely be announced, so you won't miss it. The fourth edition of A. T. M. has just gone to the printer as we write these words (Sept. 3), but when it will be ready depends upon the time it takes this one little fella to correct first, second, and third proofs, and then read the whole book in order to make a new and more complete index—a tough job in itself. So much depends upon good luck, available time, eyesight, and strength of back, that we can't yet set a date, but you won't miss this book, either—we shall of course announce it. This one—the fourth edition—is to come out first, the Supplement later. The fourth edition will not be increased in size, but there will be a number of new chapters, in place of material which is out-moded; also numerous smaller substitutions and corrections.

BENJAMIN J. Phillips, 67 Albion St., Somerville, Mass., a member of the Amateur Telescope Makers of Boston, recently sent us one hair from his head, which he had been using for a sort of Ronchi test. When tried, this proved interesting and revealing. One hair, fastened across a supporting opening or a key ring, and used with the ordinary pinhole, throws on the mirror one element of the Ronchi shadows. It will show up a zone or a turned edge about as well as an elaborate rig with fancy slits. Someone—wish we could recall who—told us a hair comb was good for the Ronchi test and we used it thereafter. No slit—merely the lamp with a cardboard around it to keep direct light out of the right eye, and the comb used as in A. T. M., page 266, Figure 3, being simply held in the two hands without complication. The jet black bars show what the mirror looks like, very clearly. The old comb works about as well as something elaborate would.

The Ronchi is a convenient side partner of the Foucault, in ordinary mirror work, but is not generally a substitute. On a short focus mirror it is a godsend for, instead of individually testing zones, as is necessary when below about $f/5$ because the depth of the shadows is then a poor gage of the smoothness of the curve, you simply look with the Ronchi, and if the bands are straight you have a sphere.

HERE is a problem for somebody: perhaps it will prove too tricky and sensitive to be practical. Perfect a dingbat which will permit an instructor to coach a beginner by watching the same shadows the beginner sees as he manipulates the knife-edge. In army rifle coaching, the coach lies prone near the prone rookie, at right angles to him and, by looking into a peep hole, sees the sights and target exactly as the rookie does, and can coach him vastly better than he otherwise could do. The rookie does the holding. Through this common link the two minds make full contact all the time. The problem would not be so simple on a mirror test—more delicate.

THE SCIENTIFIC AMERICAN DIGEST

(Continued from page 275)

is the question of obsolescence. Obsolescence and depreciation in normal year-amount to about five billion dollars. None of the replacement has been made for the last three years. Are we merely going to replace the old equipment, or are new things going to take their places?

The publications covered by the Index fall under three main classes. The largest of these is made up of periodicals or magazines devoted to engineering, pure science, other technical subjects, and industrial literature. The second class includes the transactions, proceedings, and other publications of every engineering or allied technical society anywhere in the world. The third class includes a wide variety of so-called irregular serial publications such as government bulletins, bulletins of universities, of engineering experiment stations, research organizations, and industrial companies. Altogether they comprise the one complete, authoritative index of engineering

FISH EAT FISH

CANNIBALISTIC fish may serve the cause of science. Recently, an ichthyologist found, in the stomachs of catfish, specimens of the great Caspian sturgeon, which they had previously been unable to study. He suggests that his fellow-scientists dissect the stomachs of aquatic animals with a view to finding other fish which they have swallowed.

Find Drug That Sobers Up Dogs

A DRUG that will sober up intoxicated dogs in less than half the time it took their fellow drunks to recover from an alcohol jag was reported by Prof. R. N. Harger and H. R. Hulpieu of the University of Indiana School of Medicine at a recent meeting of the American Society for Experimental Pharmacology and Experimental Therapeutics.

The drug is the yellow powder known to chemists as dinitrophenol which has recently been used to cause fat people to lose weight. Because it is very dangerous when used without a physician's supervision, the Indiana scientists particularly warn the public not to use it as a home remedy after a spree. "Severe poisonings and several deaths have resulted from its rather wide-spread use by overweight people," Prof. Harger said.

"We wish to emphasize that our experiments were done only with dogs and that the presentation at this time is solely for its scientific interest. Until further carefully supervised work is done this drug should not be used in treating intoxication in human beings.

"Otherwise, when 'hubby' returns home 'soused' at four A.M. and takes a capsule of

this drug in order to be sober when he goes to the office at nine, he might accomplish the desired result, but again he might go to the undertaker instead."

So dangerous do Prof. Harger and his associate consider this drug that they have hesitated to publish their discovery of its sobering-up effects for fear that some unscrupulous medicine manufacturer might exploit the drug as a treatment for drunkenness and thereby produce cases of serious poisoning or even death.

Their experiments showed that the drug enabled the dogs to burn the alcohol they had been given much more rapidly than the usual rate.—*Science Service.*

METAL CLEANSER

AN effective cleaner for sheet metals such as steel, aluminum, tin, galvanized iron, and so on, makes use of phosphoric acid, one of the strongest acids known to chemistry. Sold under the name "Sol-Klean," this mixture of phosphoric acid, solvents and other ingredients necessary to produce efficient cleaning is said to impart rust-proofing properties to the metal.—*A. E. B.*

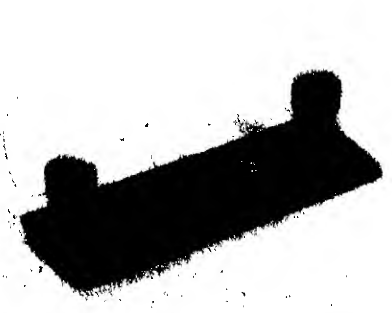
HEATED WIRE ANEMOMETER

A NEW type of anemometer, especially designed for measuring slow air movements such as are present in refrigerator cars, has been developed by the Bureaus of Agricultural Engineering and of Plant Industry, United States Department of Agriculture. Operation of the instrument depends on the cooling of a heated wire when exposed to air currents. The accompanying illustration speaks for itself.

So far, the instrument has been used to measure only horizontal velocities, but engineers believe it can be used to measure velocities of any direction. Use of the anemometer will result, it is expected, in a better knowledge of the requirements for air circulation and of the conditions under which maximum circulation may be obtained in refrigerator cars.

The instrument is small enough to be placed under the floor rack of a car and may be read from the outside without disturbing conditions inside.

Previous to the development of this anemometer, observations of air velocities in cars were confined largely to smoke tests. Puffs of dense smoke were released at certain points in cars and observations were made of how long it took the smoke to travel to other points. The general direction of air movements could be followed and



Simple heated wire anemometer

some idea of velocities of currents was obtained in this way. Difficulty of access to many positions in cars and diffusion of the smoke limited the usefulness of this method.

Also in making smoke tests, it is necessary for at least one observer to be in the car. In some cases, the presence of an observer is likely to set up independent convection currents or otherwise distort those being measured, engineers believe.

Curbing Cannibal Chickens

The peevish pullet that exhibits cannibalistic tendencies by picking at her neighbor is a real menace to the egg and chicken market. Losing her tail feathers and skin is hardly conducive to the health and

Chicken muzzle aids egg production

happiness of Madame Hen, not to mention the blow to her dignity. A hen thus blighted develops an inferiority complex, fails to eat and drink properly; in short, becomes a cull, which is an ugly word among chickens.

Nor is the evil entirely one-sided. The transgressor gets a crop full of feathers, which, though filling, are lamentably lacking in essential vitamins and such things. Thus the hen becomes ill, stomach complications set in, and egg production drops.

An ingenious method of eliminating this wasteful and unsanitary habit consists of equipping the fowls with protective devices to prevent extra-curricular picking. One of these, developed on the West Coast, consists of a midget triangular shield called a "Pikgard" which covers the beak of the chicken and pivots on a pin near the base of the beak. The guard is so balanced that it automatically falls away when the hen lowers her head to feed or drink, drops back into place when the head is raised. Made of aluminum, it is unaffected by moisture and is so light in weight that it does not interfere with the chicken's normal head movements. This device is now extensively used by poultrymen throughout the United States, as well as foreign countries, with highly satisfactory results.

Smokeless Coal

A PROCESS for taking the smoke out of coal before it has burned was reported to the American Chemical Society by S. C. Jacobsen and G. W. Carter, of the

University of Utah. Estimating an annual loss due to soft coal smoke in the United States at 500,000,000 dollars, the advocates of smokeless coal declared that a process that would eliminate soft coal smoke would easily justify the expense involved by the necessary pre-treatment. The process recommended involves treating coal with super-heated steam at 1000 to 1400 degrees, Fahrenheit, thus removing the hydrocarbons which give rise to smoke during combustion. *A. E. B.*

Wax on Wood Won't Wear Off

FLOORS and furniture that never need to be waxed to polish them are within the realm of possibility since the discovery of a process whereby wax is absorbed deeply into the fiber of the wood instead of merely covering the surface. The first step in the "embalming" process is a chemical treatment that makes the wood permeable to the melted wax. Beeswax and Stearin are among the waxes so far successfully used. Dr. A. J. Stamm, United States Forest Products Laboratory, Madison, Wisconsin, inventor of the process, states that rosin, linseed oil, and other substances that will mix with wax can also be used. The process is said to render wood waterproof and resistant to warping, shrinking, checking, and cracking. *A. E. B.*

Military Aircraft Ideas

THE United States at the moment is definitely in the lead as far as aircraft and aircraft engines are concerned. In some quarters, however, the view is expressed that Europe may take this advantage away from us under the tremendous impetus which its vast expenditures for air war purposes are certain to give. Therefore, such pessimists argue, it behooves us to forge ahead in experimentation in every possible way. A correspondent, E. Burke Wilford, the designer of the Gyroplane, sends us a number of interesting suggestions for worthwhile experiments and investigations. These suggestions he divides into two classes—those applicable to naval aircraft and those for Army use.

For the Navy he discusses, first of all, wheels in floats. When a seaplane, mounted on one or two floats is built, it requires the help of a retractible gear to convert it into an amphibian. Naturally this increases weight and complexity. Is it perhaps possible to mount fixed wheels at the bottom of the float, projecting enough to secure a land alighting machine, but so arranged with relation to the float as not to interfere with its water take-off characteristics?

A great deal of research work has been done in regard to the location of air-cooled engines relative to the wing. The engine nacelle usually is so located at the leading edge, and the motor so protected with a Venturi cowl that the combined resistance of wing and nacelle is fairly low. Perhaps this process of resistance reduction could be carried still further, by placing the engine within the wing, leading the cooling air through passages inside the wing, and driving the propeller through a shaft transmission. This would certainly bring us a step nearer to the conception of the flying wing. The problem to be solved is partly aerodynamic, partly mechanical. Experiments along these lines have already been made and should certainly be continued.

In regard to Army aircraft, Mr. Wilford is equally stimulating. When engines become extremely powerful in relation to the size of the airplane, the question of engine torque becomes important. In the Schneider Cup races the 2500 horsepower engine torque was so great that lateral equilibrium was secured only by placing one float farther away from the center than the other, and by putting all the fuel in one float so that its weight would counteract the turning moment of the engine. This would not be practicable on a land plane. The remedy here would be to use two propellers at the nose of the aircraft, one immediately behind the other, and rotating in opposite directions. Presumably one propeller would have a hollow shaft, with an interior shaft driving the leading airscrew. A subsidiary advantage of such an arrangement would be that slipstream effects on the vertical tail surfaces would be eliminated, and the problem of keeping a straight course simplified.

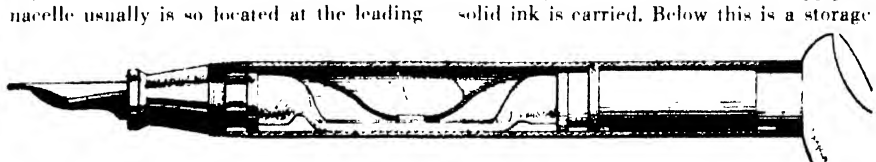
The study of beryllium alloys for aircraft use is also advocated. Beryllium is still expensive, but some of its alloys weigh less than duralumin and are stronger. Certainly nothing would make for more rapid progress in aircraft structure than an improved method of refining the vast supplies of beryllium ore available, which would bring down its cost to a reasonable level. So great is the value of weight saving in aircraft that even a relatively high cost could be absorbed without any difficulty.

It is fine, once in a while, to think broadly of the future, and not to restrict ourselves to mere refinements.—*A. K.*

Fountain Pen Filled with Water

A NEW type of fountain pen which can be filled from any supply of ordinary water, and yet makes possible writing as with ordinary ink, is called the "Camel" for obvious reasons. In the design of this pen, every precaution has been taken to make it as foolproof as possible and to cause no more trouble to the user than any ordinary pen filled with the conventional liquid ink.

In this pen there is provided a chamber in the top of the barrel where a supply of solid ink is carried. Below this is a storage



***Above:* Partial section of the new water-filled fountain, showing filling mechanism. *Right:* Section showing ink cartridge and storage chamber**

chamber and still farther down is a rubber sac provided with a means for compressing and releasing it. When water is drawn into the rubber reservoir, by pressing and releasing a button on the upper end of the barrel, the water comes in contact with the solid ink cartridge, some of the ink is dissolved, and the pen is ready for use. When the pen is carried upright in the pocket, constant dissolving of the solid ink into the water in the reservoir is prevented by the small storage chamber in which is held a certain amount of water and ink in concentrated form. Surface tension prevents this concentrated solution from reaching the reservoir except as needed to keep the liquid in the reservoir at the proper "writing color."

It is claimed that for ordinary use the solid ink cartridge in this pen, produced by the American Writing Instrument Company, will last for at least a year.

CURRENT BULLETIN BRIEFS

PROGRESS DEMANDS KNOWLEDGE is a 16-page pamphlet which explains in some detail the Engineering Index service. This Index is of inestimable value to all engineers, research workers, and executives in any technical field. *Engineering Index, National Committee, 25 West 43rd Street, New York City.—Gratis.*

PETROLEUM, THE STORY OF AN AMERICAN INDUSTRY, is an illustrated booklet of 96 pages that covers the subject completely from a definition of petroleum through its history, refining, marketing, taxation, and conservation. This booklet will be of great value to anyone who uses petroleum products in any form. *American Petroleum Institute, 50 West 50th Street, New York City.—15 cents.*

PROTECTIVE DEVICES FOR HEAD, EYES, NOSE, AND THROAT is essentially a catalog of a manufacturing organization but is unusual in that it is devoted entirely to devices which have been developed to insure safety in vărious industries. It lists, illustrates, and describes a complete line of protective goggles, welding helmets, respirators, and blasting helmets. *Willson Products, Inc., Reading, Pa.—Gratis.*

AUDUBON WIRE CLOTH describes and illustrates a complete series of various types of woven wire cloth adaptable to many industrial uses. A complete catalog is also available in addition to this eight-page folder. *Audubon Wire Cloth Corporation, Castor Avenue, Allen & Bath Sts., Philadelphia, Pa.—Gratis.*

BROOKVILLE LOCOMOTIVES describes a full line of industrial locomotives ranging from two and one half to six ton models, all powered with Ford V-8 engines. *Brookville Locomotive Company, Brookville, Pa.—Gratis.*

TIP TOP TUBES are made of various flexible materials such as paper, cloth, cellophane, and so on, and are adaptable to packaging of many different types of manufactured products. The tubing is available in all sizes and is readily sealed by a cleverly designed machine. A pamphlet describing these tubes will be mailed gratis on request. *Midland Products Inc., 3176 Brannon Avenue, St. Louis, Mo.*

THE PROBLEM OF THE FAR EAST

(*Continued from page* 239)

tance from Europe, is in the best position to oppose the further dismemberment of China by Japan. But we are engrossed for the time being with our domestic situation and plagued by national scuttlers who would give up our foreign trade and over-seas possessions in a childish effort to secure peace by becoming a hermit nation like China was. For the moment, Japan seems to have everything her own way.

IS THERE A REMEDY? Is there still a chance to save China? On first examination the answer would certainly be "No!" Torn by internal dissensions, militarily feeble in comparison with Japan, lacking interior communications, and temporarily denied outside assistance due to European rivalries and our domestic situation, China seems an easy prey for Japan.

A POSSIBLE SOLUTION. There is great latent resistance in the Chinese people, there is a national spirit that can make itself felt, and *perhaps* it will make itself felt long enough and strong enough to delay the progress of Japan until the inevitable consequences of Japan's success become more plainly apparent and force Great Britain and the United States to take joint measures to stop this alarming advance.

THE WOEFUL ALTERNATIVE. If the statesmen of these two great countries can not find a formula for joint action in the near future, they will witness not only the extinction of the century-old trade with China but they will see a Japan securely entrenched in an almost impregnable line of islands extending from the Kuriles through the Philippines to the Dutch East Indies. Australia and New Zealand will then lie at Japan's mercy and the western Pacific will become a Japanese lake.

Some Jeremiahs will doubtless say it is already too late, that Japan is already unassailable in the Far East. These doleful souls should recall how securely Napoleon *seemed* to be established in Spain, and how easily he was ejected when the Spaniards united and decided to resist, and Great Britain with her sea power and small army seized the opportune moment and came to thé rescue. There is still hope for China if the Chinese will keep up their resistance long enough for Great Britain and the United States to realize the inevitable implications of Japan's further encroachments on China. Given this realization, the opportunity will soon arise for successful and comparatively easy intervention by the two great sea powers, and the grandiose plans of the Japanese war lords will tumble like a house of cards about their Chauvinistic heads.

CAMERA ANGLES

Conducted by JACOB DESCHIN

Greetings by Photography

GIVE your friend a basket of fruit culled from your own garden and he'll appreciate it no end, vastly more than the fanciest you could purchase. The same applies to greeting cards, whether during the holidays or for special occasions, such as birthdays. A greeting card you have made

Examples of photographic greeting cards described in these columns

yourself will be the only one like it in the world—unless you make a number of copies yourself—and the person who receives it will know you mean everything you say.

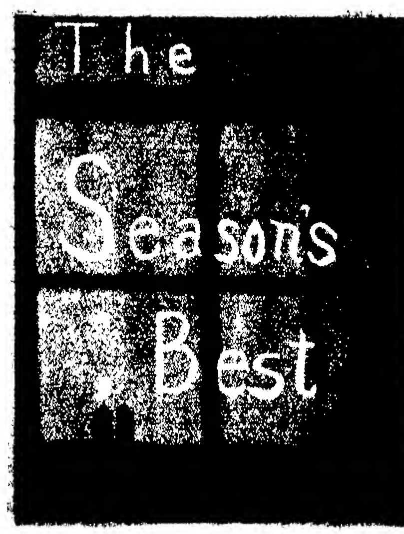
The making of greeting cards by photography appeals enormously to the imagination, for it leaves one free to roam the whole world of fancy and fun to choose the design suited to the occasion and the person for whom it is intended. A greeting card may be planned as a single copy for one person and no other or it may be printed a great number of times for distribution to a great number of people, as at Christmas or New Years. The latter, of course, must be so arranged that it will be sure to have a general appeal, yet be far beyond the stereotyped method.

Bookplates may also be designed and completed by the same methods employed in making photographic greeting cards. By making one's own bookplates, different ones may be designed for different classifications of books in one's collection, such as volumes of history, fiction, poetry, and so on.

The simpler the subject matter, the more appealing the greeting card or bookplate. All outdoors as well as indoors is good hunting. A bookplate may reflect one's hobbies or tastes, a greeting card may show a picture of a subject mutually familiar to sender and receiver, such as a charming picture of the baby or of a corner in one's garden. No worth-while subject will be found too trite if it means something to you or your friend and is tastefully handled.

Greeting cards may consist either of a photograph mounted on a white or buff card with even spacing at top and sides and doubling the margin at the bottom, as in mounting any picture, with the sentiment written in on each card in one's ordinary handwriting, or they may be more elaborate. The two here illustrated are examples of the latter. Neither required any great ingenuity and may suggest to the reader other and better methods.

The one showing the two youngsters watching a puppeteer at work is the result of two separate negatives, one showing the



boys and the puppets and strings, the other the holiday string formed into the word, "Greetings." An ordinary large white blotter was used as the background for the latter. The two negatives were placed in the holder together and printed through simultaneously.

"The Season's Best" card was made by projecting a cardboard cutout of a window with a piece of cheesecloth thrown over one side of it to simulate a curtain. An ordinary white sheet was used upon which to project the shadow design. The lighted candle in the corner helped along the sentiment as well as aiding in the composition. The sentiment was hand lettered in opaque

directly on the photographic negative.

It is a matter of choice whether the greeting card shall be a single card or a folder. In the latter case it seems less wasteful to mount the print on some sort of mounting cardboard than to print on a large piece of sensitized paper so as to have enough left over to fold.

In the bookplate illustrated the lettering is a separate negative in which anagram blocks were arranged on a blotter. A print

A photographic bookplate

was first made of the learned hobby horse negative, the latter removed and the lettered negative inserted in the proper place, all but the lettered portion of this negative being held back by a piece of cardboard which at the same time "dodged" in the lettering.

Since bookplates are intended for pasting into books, a very thin printing paper should be used. The paper generally employed for this purpose is that known as "insurance bromide" and may be obtained for you by your dealer.

The use of such materials as string, paper clips, sugar or salt sprinkled on a black cloth, lend variety and humor to the designing of the lettering in greeting cards and bookplates. Other materials for this purpose will readily suggest themselves to the worker when he starts thinking along these lines.

Negative File

THE importance of carefully storing negatives to protect them from dust as well as to make them easily accessible, is realized by all serious workers. The "Book of Negatives," recently brought out, is a file, bound in imitation leather stamped in gold and having the appearance of a book, consisting of transparent glassine containers arranged to accommodate negatives up to and including size 116. Its capacity is 100 to 400 negatives, depending on the size.

"Bas-Relief" Photography

CONSIDERABLE interest has been aroused recently in an old process by which an ordinary photographic print is made to give the appearance of a piece of sculpture in low relief. One starts with a negative, which is placed in contact with a glass plate or film and then exposed, thus producing a transparency. The negative and the positive, or transparency, are then placed face to face and about 1/32nd inch off register, and bound all around with gummed cloth or paper. The negative-positive may then be used either for contact printing or making enlargements.

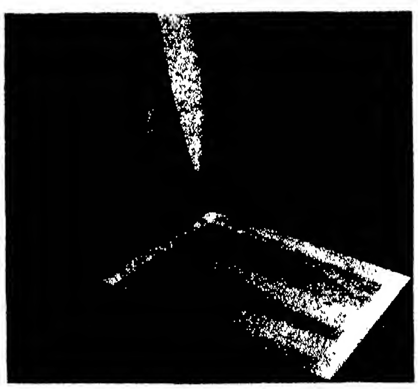
Flash Synchronizer for Small Cameras

EVEN miniature camera users may now enjoy the advantages of the photoflash synchronizer formerly almost exclusively available to the press cameraman. The Kalart synchronizer is now readily adaptable to the smallest as well as the larger cameras and opens up a vast new field for amateur exploitation—the taking of fast action pictures at night. Speeds as high as 1/200th of a second at night are not unusual with such an aid as the photoflash synchronizer.

Home-Made 11 by 14 Mask

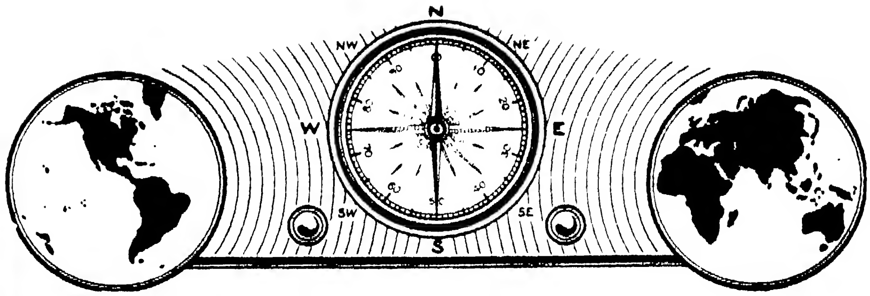
THE worker who finds occasional use for a mask larger than the largest accommodated by his regular easel can solve the problem easily and cheaply by constructing one himself. The materials needed, which may be purchased for less than a dollar, are an artist's drawing board, because of its non-warping characteristic, a piece of stiff cardboard the size of the drawing board, some black adhesive tape, a straight edge and a knife with a sharp point. Any artists' supply store can furnish these materials, if they are not already available.

The particular mask here described was made to take 11 by 14 inch paper and provided for a half-inch border all around. The cardboard was first cut to fit the dimensions of the drawing board. An opening was then cut in the cardboard with the sharp knife to measure 10 by 13 inches and



The home-made mask

sharp edges assured by lining the edges with black adhesive tape. The mask was then made fast to one end of the drawing board by means of the same adhesive tape, inside and outside, so that the mask could be "opened" and "closed" like a book. With the mask down, a line was then marked for the inside dimensions, the portion of the paper to be exposed. "Opening" the mask, a rectangular line was then drawn in ink 11 by 14 inches to provide for the accurate placing of the paper. To insure sharp borders the mask may be held in close contact with the paper by means of weights or push pins or both.



WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN*

The Beat-Frequency Oscillator

When you are cruising through the numerous wave channels in search of new stations, or merely seeking a desired short-wave broadcaster, there is no assurance that you will hear each and every station tuned in. The stations are there, but a number of them may escape your notice.

This inability to spot all short-wave broadcasters on the air within the range of the receiver is no reflection on your technique of tuning, nor on the qualities of the radio set. The apparent absence of stations at their proper dial-scale settings is frequently due to other causes.

Short-wave signals are subject to rather severe fading at times. Therefore, though the receiver may be tuned to the proper frequency for a given station, the signals may be so weak that they are lost in the background noise. Yet a few minutes later signals from the very same station may roar in.

The condition of fading is further aggravated by the fact that foreign short-wave broadcast stations are more often than not run for extended periods with an unmodulated carrier; that is, the signal carrier is left "on the air" minus a program transmission. So long as a station carrier is unmodulated there is nothing to be heard except possibly a gentle hissing sound. If the carrier is passing through a period of fading while unmodulated, there certainly will not be any evidence of its presence at the receiver.

Since the carrier wave of any radio transmitter has a frequency far beyond the audibility of the ear, it cannot be heard through the medium of the radio receiver, unless it is modulated by an audible frequency. Consequently, a listener may readily skip by numerous short-wave broadcast stations without realization, or assume that a desired broadcaster has failed to maintain its program schedule.

Happily there is a simple solution to this problem; one may attach to his all-wave receiver a small device, known as a "beat-frequency oscillator," that will make each and every station carrier distinctly audible, irrespective of whether or not the carrier is modulated. Several radio manufacturers market this device in unit form so that it may be employed as an auxiliary tuning contrivance or "station finder." These units can be used only with receivers of the superheterodyne type.

The beat-frequency oscillator generates electrical oscillations which are, like a broadcast-station carrier, above audibility. The oscillations are injected into the receiver circuit and made to "beat" with the station carrier in a manner such that the resultant frequency is audible in the loud speaker. The following explanation will provide a better understanding of just what takes place:

In a superheterodyne receiver all signals

A standard beat-frequency oscillator

received are converted to some lower, intermediate frequency, before they are actually detected and made audible. If the intermediate frequency of the receiver is 456 kilocycles—and this is a frequency commonly used—then all signals tuned in are converted to this frequency. Now, if a beat-frequency oscillator is attached to the receiver and its frequency adjusted to, say, 454 kilocycles, there will be three rather than two frequencies in the detector circuit—the original 456-kilocycle frequency of the signal, the 454-kilocycle frequency of the beat-frequency oscillator, and a "beat frequency" of two kilocycles, which is the difference between the first two frequencies.

Now the beat frequency of two kilocycles is audible. A kilocycle is 1000 cycles; therefore two kilocycles is 2000 cycles—well within the range of the ear.

If the beat-frequency oscillator were to be set at 452 kilocycles rather than 454 kilocycles, the resultant beat would still be audible. The beat frequency in this case would be four kilocycles, or 4000 cycles. The beat-frequency oscillator is provided with a small adjusting knob so that the listener may select the most desirable beat frequency. Once this adjustment has been made, it

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

need not be touched again when tuning.

In operation, the beat-frequency oscillator is turned on and the receiver tuned in the usual manner. Each time the receiver dial pointer reaches the setting for a broadcast station which is on the air, an audible whistle is heard in the loud speaker. The beat-frequency oscillator is then turned off, at which time, of course, the whistle ceases, and in its place will be heard the program or possibly nothing at all if the carrier is unmodulated or passing through a fading cycle. In any event, there is little chance of skipping by a station inadvertently.

The question may arise as to why even a whistle can be heard, when using a beat-frequency oscillator, under conditions of maximum signal fading. This is due to the fact that detection of a signal carrier by the beat-frequency method is many times more sensitive than the usual rectification means of reception. It cannot be used for the detection of broadcast programs because of the interfering whistle.

Timing Programs

THERE are a number of electric time-clock switches now on the market specially designed for use in conjunction with radio receivers. In place of the minute and hour hands, these devices have two adjustable pointers; one for "On" and one for "Off."

Hooked into the electric supply to the receiver, a device of this sort may be used to turn on the radio set at any desired time, and turn it off again at the completion of a program. This would suggest that, aside from its use as an automatic reminder, the device can be employed as a "radio alarm clock," or as a means of turning off the radio at some pre-determined time after one has retired for the night.

Cabinet Design

RADIO cabinet design has long been tied to the apron strings of custom. It has been presumed that the radio instrument should be disguised rather than revealed;

No disguise for this radio set

that it should have an exterior which will induce the impression that it is something other than an instrument of sound reproduction.

It is encouraging to learn that one manufacturer, realizing that the radio instrument, like other mechanisms, should have an exterior design compatible with its function, has indicated a willingness to experiment with the idea.

There is shown in an accompanying illustration one of the new Sparton all-wave sets which, to say the least, is breath-taking in appearance. The cabinet is a midnight blue mirror with chromium steel trim. It was created by the well-known industrial designer, Walter D. Teague.

This cabinet design is interesting because it is functional. Primary consideration has been given to the mechanics of the instrument, rather than to the influence of early cabinet makers.

Although purely experimental, the Teague design may prove to be the forerunner of a functional era in radio cabinets.

Multiple Aerials

BETTER results may be obtained from all-wave receivers by employing two antenna systems in conjunction with a change-over switch.

Since most antenna systems have directional characteristics, the use of two, strung at right angles, permits the listener to use the one that will bring in the desired signal with the greatest volume.

The two transmission lines are attached to the contacts of a double-pole double-throw switch; the antenna and ground terminals of the all-wave receiver are connected to the switch blades. Thus the change-over problem is simplified.

Changing from one aerial to the other will often bring up a weak signal to sufficient volume to be understandable.

Five-Meter Reception

QUITE a number of the 1936 all-wave receivers are equipped for reception on frequencies as high as 60 megacycles. Heretofore it was necessary to use a separate receiver for covering such high frequencies.

One of these new all-wave receivers covers the ultra-high frequency band extending from 18,000 to 60,000 kilocycles (18 to 60 megacycles). In this band are a number of foreign broadcasters, two amateur bands and an ultra-short-wave police radio band . . . unexplored territory to the average listener.

Some real long-distance reception is possible in the vicinity of 18 megacycles. However, very little "distance" reception may be expected at frequencies around 60 megacycles. Nevertheless, the amateur 5-meter band, in the vicinity of 60 megacycles, has become very active and suffers less from interference than do the 20- and 80-meter 'phone bands.

Pre-Selectors

A PRE-SELECTOR is a self contained, and usually self-powered, tuned radio-frequency amplifier. The sensitivity of any superheterodyne all-wave receiver may be increased considerably by the addition of this device. Aside from increasing sensitivity, the pre-selector also reduces "image interference" and increases receiver selectivity. Using a pre-selector is the simplest way of boosting all-wave receiver results outside of purchasing a new set.

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

CONTENTS · DECEMBER · 1935

COVER

ONE of the towers of the Triborough Bridge (see page 323) stands in bold relief against a background of the sky, as photographed by Jacob Deschin, conductor of our regular monthly department "Camera Angles".

The SCIENTIFIC AMERICAN DIGEST

28119/136

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50 Years Ago in . . .

Scientific American

It is frequently the case that present-day advances in science and industry can be more fully appreciated when there is available some knowledge of what has gone before. The accompanying excerpts from Scientific American for December 1885 were selected from our files for their inherent interest and significance. If you would like to see this page continued as a regular feature of Scientific American, won't you write us a note to that effect?

ORSON D. MUNN, *Editor and Publisher*

PASTEUR—"The entire civilized world has for some time past been watching with intense interest the experiments on the treatment of hydrophobia conducted by the celebrated French scientist, Dr. Louis Pasteur. These researches have now been so far completed that the results have been presented by the investigator to the French Academy of Sciences."

BALLOONS—"At a recent meeting of the Military Service Institution, held at Governor's Island, Gen. Russell Thayer, of Philadelphia, presented in detail his system of independent and dependent dirigible balloons, intended particularly for use in war times. General Thayer has made many experiments in aerial navigation, and has so far been successful that a number of his designs and working models are now under consideration at the British War Office."

ALUMINUM—"According to *La Lumière Electrique* Mr. L. Senet has invented a new process that permits of the manufacture of aluminum, as well as copper, silver, etc., by electrolysis. A current of from 6 to 7 volts and 4 amperes is made to act upon a saturated solution of sulphate of aluminum in the presence of a solution of chloride of sodium, the two solutions being separated by a porous vessel."

ASPHALTED JUTE—"According to the *Journal des Fabricants de Papier*, a material called asphalted jute is being largely employed in Germany for covering roofs, for isolating damp walls and floors, and for preventing bad odors from reaching apartments situated over stables, etc."

ANDROMEDA—"The new star in Andromeda, which was first seen by Ward, at Belfast, on August 19, as a star of the ninth magnitude, and two days later reached its greatest brightness as one of the seventh magnitude, is now fading at the rate of one magnitude in 18 to 21 days, and has reached the lower brilliancy of a star of the eleventh magnitude."

MECHANICAL STAMP SALESMAN—"An English invention is designed to do away with complaints about a want of post office agents for the sale of stamps. The apparatus is a mechanical box which automatically transacts the business of selling stamps, etc., and may be put up on lamp-posts like the letter boxes."

ASPHALT—"French rock asphalt pavement in the city of London still holds its own; and while no asphalt has ever been taken up to replace it with wood, there have been cases where the wood has been taken up and replaced with asphalt."

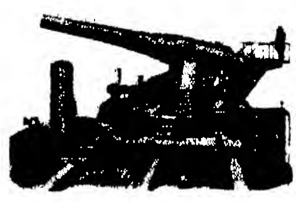
GARNET—"While making the excavations for a sewer on 35th Street between 7th Ave. and Broadway, New York City, the workmen recently uncovered a large garnet which was enclosed in the gneiss about nine feet below the level of the street."

BESSEMER—"A recent improvement in the Bessemer steel process as carried out at the Edgar Thomson Steel Works, near Pittsburgh, will have the effect, it is said, of making Bessemer steel equal in quality to the crucible product, and at only about one-tenth the price."

OBELISK—"The work of preserving the Obelisk at Central Park, New York, has now been completed, and apparently none too soon, as the numerous storms which have since assailed the shaft would have done it material damage had the pores of the stone still remained open. The process employed consisted of treating the heated stone with a mixture of paraffine, creosote, and turpentine."

JEWS—"The *Bulletin* of the Geographical Society of Marseilles estimates the total number of Jews in the world at 6,377,602—that is, 5,407,602 in Europe, 245,000 in Asia, 413,000 in Africa, 300,000 in America, and 12,000 in Oceania."

RUSSIAN CANNON—"Messrs. Easton and Anderson recently issued invitations to officers of Government manufacturing departments and foreign attachés to visit their works at Erith, in order to inspect the Moncrieff gun carriages made by them for the new Russian ironclad *Catherine II.*" The gun mounting was a cast steel platform revolving around a hollow steel pivot on 22 rollers. The gun was of the "disappearing" type and was provided with a clever variable hydraulic recoil mechanism.



DYNAMITE AIR GUN—"Three dynamite projectiles were thrown from Lieut. Zalinski's pneumatic gun, at Fort Lafayette, New York harbor, on the afternoon of Nov. 28. The projectiles were thrown a distance of about two miles, and two of them, one containing 50 and the other 100 lbs. of nitro-glycerine, exploded in a most satisfactory manner, the other one sinking in the water without exploding. . . . The air pressure employed in the new gun was 1000 pounds to the square inch."

NICARAGUA CANAL—"An official report has been submitted recently to the Navy Department by Civil Engineer A. G. Menocal, U. S. N., of the relocation of the Nicaragua Canal made by the government expedition of last winter. The route now given the preference extends from the harbor of San Juan del Norte, or Graytown, on the Caribbean Sea, to the port of Brito, on the Pacific, a total distance of 169.8 miles, of which 40.3 miles are canal proper and 129.5 miles open navigation through Lake Nicaragua, the river San Juan, and the basin of the river San Francisco."

AND NOW FOR THE FUTURE

"Making 'Radium' Artificially," by Prof. E. U. Condon. Substances of great therapeutic value.

"Civil Aviation in National Defense," by Reginald M. Cleveland. Can transports be made into bombers?

"The Food of Pekin Man," by Dr. Ralph W. Chaney. Man's first dietetic record discovered.

A study of the possibilities of Diesel engines in battleships, by Capt. A. M. Procter, U.S.N. (Ret.)

"Seeing the Invisible," by de Bary Kerston. Sound waves investigated by photography.

THE GIFT OF FRIENDSHIP

THERE is a priceless gift within reach of every one—the gift of friendship.

Of all the services of the telephone there is none more important than this—helping you to make friends and to keep them.

When people are in trouble, you go to them quickly by telephone. The telephone carries your good wishes on birthdays, weddings and anniversaries. Arranges a golf game or gets a fourth for bridge. Invites a business acquaintance to your home for dinner, and advises "home" that he is coming. Congratulates a youngster on his work at school. Thanks a neighbor or asks about the baby. Renews old times—shares confidences—plans for the future.

Thus the bonds of friendship are formed and strengthened. Greater happiness comes into the widening circle of your life. Some one, somewhere, says sincerely—"It was nice of you to call." This day, a voice-visit by telephone may bring reassurance to some friend who is wondering how you are.

More and more are people turning to Long Distance to carry friendly voices across the miles. They like its speed, clarity, intimacy and low cost—especially after 7 P.M., when calls by number to most points cost about 40% less than in the daytime.

BELL TELEPHONE SYSTEM

CANADA'S NEWEST AID TO SCIENCE

WITH the 74-inch telescope of the University of Toronto now in use—second largest telescope in the world at present—the center of gravity in regard to things astronomical on the North American continent shifts to the north-eastward, for important research will be done by means of it. The photograph does not well indicate the size of the instrument: the tube is 28 feet long. Attached to it is a spectrograph. The telescope was made in England by Sir Howard Grubb, Parsons and Company. The mirror disk is American Pyrex. It was figured by Grubb.

A military plane lays a dense smoke screen. Instead of this harmless chemical, the plane might use one which would cause heavy casualties in men. *Inset:* A modern service gas mask

No Super War Gas!

Ideal War Gas May Never be Found . . . Requirements and Limitations . . . Nations Still Rely on Wartime Combat Chemicals

By ALDEN H. WAITT
Captain, Chemical Warfare Service, U. S. Army

WAR gas is deadliest in the minds of enterprising newspaper reporters whose imaginations have run riot for years. In fact, so much pure, unadulterated hokum has been written by them since the World War, that it is quite a relief to read Captain Waitt's accompanying article and find that war gas is not, *can not be,* anything like as deadly as most people believe. This author, an authority on chemical warfare, thoroughly de-bunks this subject which has so intrigued the sensation-mongers.—*The Editor.*

OF the many hundreds of poisonous substances known to the chemist, the few that are important as agents of chemical warfare may almost be counted on the fingers. The layman finds this difficult to understand. As a matter of fact, he generally refuses to believe it. Mr. Average Citizen is convinced that there are dozens of new and secret formulas tucked away in the locked files of the war offices of the world ready to be brought out at the first suspicion of war so that fiendish brews may be prepared and used for his destruction.

Mr. Citizen, however, is wrong. It isn't as simple a matter as he thinks to add to our list of chemicals useful as weapons. The difficulty lies in the many essential factors that enter into the problem. The chemical warfare agent not only must have toxic or irritant properties sufficient to cause casualties or disable in extremely low concentrations, but it must possess also suitable physical and chemical characteristics, and meet rigid economic standards. To find a material that will combine enough of the desired properties to be useful is a tremendous task. To find one that will combine all requirements is practically impossible. The ideal chemical combat substance has not yet been found. Probably it never will be found.

From 1915, when the first gas attack took place near Ypres in Belgium, to 1919, when the war-time research establishments were placed on a peace basis, or completely demobilized, over 3000 compounds were carefully investigated. Less than 30 of these were of sufficient value to be used in actual hostilities and only some 10 or 15 were found satisfactory for use on a large scale. The field was covered in those years by the most eminent chemists of the times in the intensive search for something that would surprise and defeat the other fellow. Since then the search has continued, although perhaps less intensively,

and in spite of the innumerable reports about a super gas that have appeared in the newspapers of the world, there is no real evidence that such a compound has been discovered. Upon tracing down these reports one finds that the alleged ideal gas has been investigated before and found wanting or that it lacks certain of the qualities absolutely necessary for successful use in war.

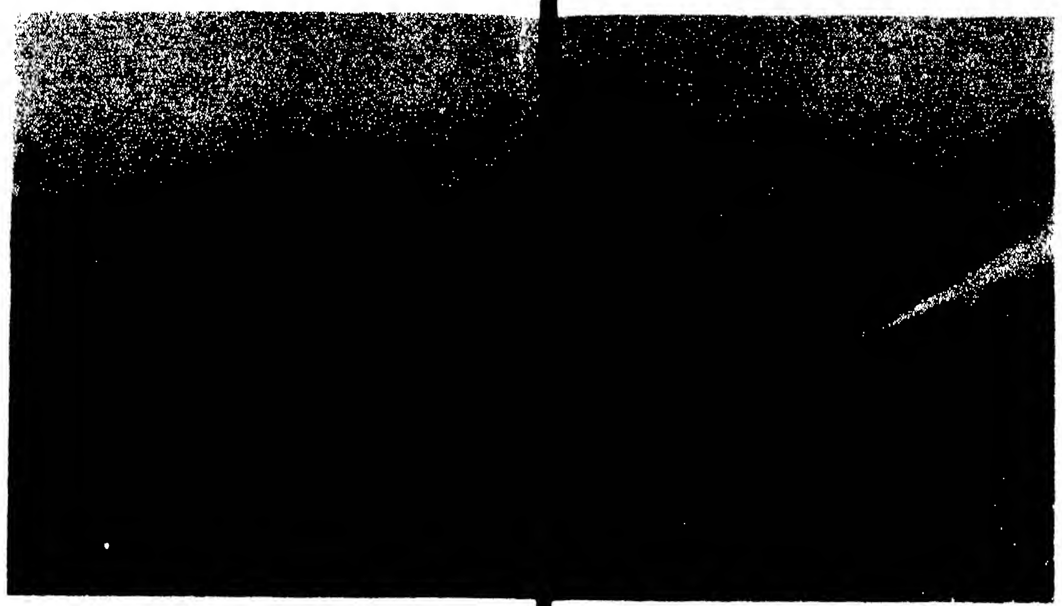
Before examining further into the characteristics that the military chemist is seeking in his ideal, let us ascertain just what a war gas is, what it must accomplish, and how.

The word poison gas is a misnomer. Most of the chemical combat substances are liquids or solids under normal conditions. They are disseminated in the air by various methods. Some chemicals are contained in artillery shells or bombs which explode and throw the liquid or solid agent into the air in drops or in fine particles. Some solids are volatilized by heat and thus pass into the air as vapor or in a fine particulate cloud. Others are carried in tanks on planes and released into the air so that they fall to the ground in droplets or as a fine mist. These latter are liquids, although the same method might be applicable to finely pulverized solids.

Chemical mortar in action

A few—those which are volatile—which enter the gaseous state readily, can be released directly from cylinders or drums merely by opening a valve. They form a dense cloud which is carried by the wind. Whether we call these materials chemical agents, combat chemicals, or poison gases, the terms all refer to any substance useful in war which, by its normal and direct chemical action produces either a powerful result on the body, a screening smoke, or an incendiary effect.

Obviously, if a search is to be started for a warfare chemical a military requirement for it must exist. There has to be some tactical need for it. Further, it must fulfill that need more effectively and better than something that already is available. Consequently, in examining the combat chemicals we often find it desirable to group them according to their tactical uses. They may be employed tactically to produce casualties, to harass, for screening, or as incendiaries. Many of them fall into more than one class. Casualty agents are those having properties which adapt them primarily to the infliction of casualties; their purpose is to put the individual exposed to them in the hospital or cause his death. Harassing agents are used to reduce the effectiveness of troops by compelling them to wear the gas mask. Screening agents form an obscuring smoke and interfere with observation, while incendiary agents cause destruction of material.



Gas cylinder attack: chlorine and phosgene spouting from ground cylinders

THE tactical purposes are accomplished by their action on the body and perhaps the most convenient classification of the war gases for the purposes of this discussion is according to their physiological effect. The lung irritants are those which attack the breathing apparatus only. They are essentially casualty agents. Phosgene (CG) is typical of this class. The skin irritants or vesicants (blistering agents), typified by mustard gas (HS), affect all parts of the body, cause inflammation and blistering of the skin, acute inflammation of the eyes and respiratory tract. The skin irritants are principally for casualty action, but also are valuable for harassing and for making ground untenable by unprotected troops. The eye irritants or lacrimators (tear gases), valuable only for harassing, produce, in extremely low concentrations, an intense irritant effect on the eyes so that vision becomes impossible. CN (chloracetophenone) is the type agent of this class. The nose irritants or sneezing agents, sometimes called sternutators, cause sneezing, nausea, and extreme mental depression. DM (diphenylaminechlorarsine) is typical of this class which, like tear gas, is for harassing purposes but to a greater degree. The nose irritants produce only temporary casualties and do not cause death. Finally there are the paralysants, or nerve poisons, such as hydrocyanic acid gas, which act directly on the nervous system, causing stoppage of heart action, and the poisons such as carbon monoxide, which act upon the blood to upset its function of supplying oxygen to the tissues. No practical method has yet been discovered of utilizing either the nerve or blood poisons as war gases because of their physical and chemical deficiences. Carbon monoxide, generated by the bursting of high explosive shells, has claimed many victims, but these casualties may not be considered as due to chemical warfare.

Qualities of the chemical agent which give it tremendous value are its ability to shoot around corners and the fact that it is continuous in time and space. The bullet or high explosive shell speeds on its way or bursts and immediately the effect is over. If anyone gets in the way a casualty is caused; if not, no result is obtained. The gas, however, diffuses in the air so that it is effective over a greater area than the explosive or bullet, and for longer periods of time. It sinks into low places and penetrates crevices.

THIS does not mean that gas cannot be controlled or that once released from bomb or shell a chemical agent may be carried for miles to destroy those whose destruction is not contemplated. On the contrary, it can be controlled to a greater extent than any other weapons except those of the thrusting type. It is a very flexible agency in that it can be designed to cause severe casualties or merely to harass and cause delays. It can be controlled definitely in time and space. It can be used to cover a relatively large area or a small area. It can be placed on the ground where its effect under average weather conditions will be exerted for several hours or days, or it can be disseminated in such a way that the effect is over in a few minutes. This is governed by the method of dispersal and by the persistency of the gas. A gas is called non-persistent if, when dispersed in the field, it is dissipated rapidly, say in 10 minutes, under the influence of a low velocity wind. A gas is considered persistent if it remains effective for longer periods—say several hours. Phosgene (CG) is a non-persistent gas and when dispersed in the field will become a vapor and be

blown away rapidly. Mustard gas (HS) is a persistent gas which, when dispersed in the field, may be effective for several hours or several days. Persistency is extremely important in its relation to the tactical uses of an agent.

The search for the ideal war gas, then, is governed by tactics, physiology, physics, and chemistry. In addition, since we fight with dollars as well as with men, the procurement agencies demand that careful attention be paid to economics. Obviously, then, a compromise is necessary since the ideal probably cannot actually be realized. We can set up the ideal, however, even if it may never be attained. It gives the military chemist an aiming point.

IN the first place a chemical combat substance must be effective in small concentrations. Let there be no confusion here as to what is meant by the term small. It is a matter not of a few parts of the substance to 100 or 1000 parts of air, but rather of a relatively few parts of the combat substance to a million parts of air. Unless the gas can do its work in these almost infinitesimal quantities it has no value in warfare. The number of shells or containers that can be brought up to the forward areas and fired is limited. Moreover, the amount of substance the air will take up is comparatively small. The chemical must be so powerful that the few pounds of it that reach the enemy positions are able to accomplish the tactical mission set for it—that is, to produce casualties, to harass, or to deny ground.

Phosgene, according to Dr. Rudolph Hanslian[1], the German authority on chemical warfare, will cause severe irritation of the respiratory organs and eyes immediately in a concentration of .04 of an ounce per thousand cubic feet of air. That is about one part in 100,000. In very much smaller quantities, if inhaled for a few minutes, this gas may lead to fatal cases of poisoning.

The tear gas, CN (chloracetophenone), produces its effects in much smaller concentrations. Hanslian states that the minimum concentration necessary for irritating the eyes is .0003 of an ounce per thousand cubic feet of air. CA (brombenzylcyanide) produces an intolerable effect on the eyes after three minutes exposure to a concentration of .0008 of an ounce per thousand cubic feet of air. Let your mind play with a conception of this small weight of substance for a moment. Just imagine that an ounce of this chemical is divided into 10,000 parts, and that eight of these parts are disseminated evenly in the air contained in a box ten feet on a side. The average man could stand the effect of the tear gas in the box for three minutes; then the irritation on his eyes would be so great that he would be compelled to close them. That is why the tear gases may be so valuable in war. Although they do not cause serious or permanent casualties, it only requires a little bit to make a man put on his gas mask, with the loss in his efficiency that wearing the mask entails. It may be cheaper to use them for certain purposes than to use a more toxic gas which has to be employed in much larger quantities. If the tactical need is to delay, harass, or hamper the enemy's operations, one shell filled with a powerful tear gas will do the work of at least ten mustard gas shells. Some nations realize this and are planning to combine small amounts of a solid tear gas in their high explosive shells. The Russians suggest the use of a splinter chemical shell which bursts to give the explosive effect without appreciable loss in efficiency and at the same time sets up a tear gas concentration in the air.

MUSTARD gas is another that the ideal gas must compete with in effectiveness. The fatal dose to the lungs is between .006 and .2 of an ounce per thousand cubic feet of air, depending on the time the victim is exposed. The eyes may be injured by concentrations as weak as 1 part in 14,000,000, but this, of course, is on long exposure. The odor of mustard gas is perceptible in concentrations as low as one part of the agent in 10,000,000 parts of air, and yet burns on the body have been caused by sitting on ground contaminated with traces of the substance where no odor was observed.

It should be noted in connection with the foregoing that the concentration is only one factor that influences the production of a casualty. The length of time of exposure is also of prime importance.

The effectiveness of the compound in small concentrations, however, is only the first of our requirements for an ideal war gas. There is still a long way to go. Our ideal agent must next be difficult to protect against. It should be able to penetrate the enemy's protective equipment or at least tax it severely.

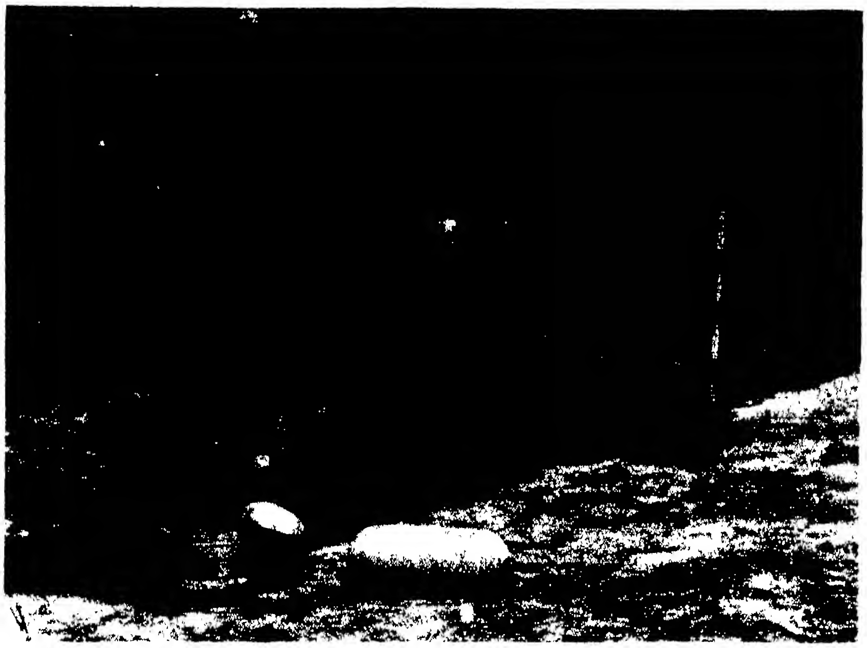
Every modern nation now has developed first-class protection against gas. If the hypothetical new gas cannot penetrate this protection, it is valueless unless surprise can be effected and the soldier caught without his anti-gas equipment completely adjusted. This is not going to be an easy matter in the future, considering the great lengths to which the nations of the world are going in their training of men in defense against gas. True, there is a definite advantage in forcing the other fellow to mask, but already we have plenty of agents that will accomplish that purpose cheaply and well.

THE new gas must do more than cause masking. It should attack all parts of the body—that is, it should be a combination lung, eye, skin, and nose irritant. Here again it must compete with mustard gas which, in both the vapor and liquid state, affects the lungs, eyes, and skin. The property of vesicant action on the skin was one of the principal reasons that mustard gas came into use. Practical protection from head to feet is not easy to obtain. In order that a soldier be safe against a spray of liquid mustard gas from the air he must be encased in some sort of impermeable garment which, of course, would be uncomfortable to wear and impossible to fight in for more than a few minutes.

If the new gas does not affect all parts of the body, it should be able to break through the mask. To do this, it must be unreactive. In other words, it should not combine readily with other materials. Moreover, it should not be adsorb-

Mechanized chemical mortar unit

[1]"Der Chemische Krieg"—by Rudolph Hanslian—Berlin, 1927.



Livens gas projector emplacement

ed easily by activated charcoal, the important material of the gas mask canister, and should not be held back by the smoke filter that removes small solid or liquid particles. The more unreactive a gas, the more difficult it is to find something to prevent it from passing through the gas mask canister. Although chlorine, the classical war gas, is highly toxic, it is an extremely active chemical and combines readily with many other chemicals. Consequently, it has always been an easy matter to protect against it. A cloth pad saturated with washing soda will filter it out of the air. Chlorpicrin (PS), another war-time agent, will remain a threat in war because it taxes protective equipment. Only the best gas mask will remove high concentrations of chlorpicrin, which is a comparatively unreactive chemical. The ideal gas, therefore, must be unreactive and should affect all parts of the body. Thus, to be completely protected, the man would have to wear a mask that would keep out the gas and provide oxygen to sustain life, and impermeable garments that would encase him from head to foot.

PERHAPS in some test tube such a material exists, but the jump from the test tube to large-scale production is a hurdle that has thrown a number of chemicals. Your war gas must be easily manufactured in large quantities. Although it may take only three drops of a substance to kill a man, it may be necessary to use a ton in order to assure that the three drops reach the victim.

The sensationalists delight in describing how a few airplanes equipped with chemical bombs or spray could wipe out cities. Of course, it is absurd. A plane might carry enough poison in one tank to kill every individual in a city if each molecule of the poison could reach its target—but that's the rub. Most of it will never reach a human being. It's like putting salt on a bird's tail. Therefore, to assure that enough of an agent reaches a target, hundreds of pounds of it must be used just as hundreds or thousands of H. E. shells must be fired to cause a few casualties; although pound for pound the gas has a wide advantage over the high explosive in putting men out of action.

In any event, no matter how powerful the gas, great quantities of it must be available. The fact that the chemist is able to produce a few pounds in the laboratory does not mean that the chemical engineer can turn the substance out by the ton. It is a long and laborious task to find a reliable and practical method for manufacturing some chemicals in quantity. During the World War the Germans manufactured about 5000 tons of mustard gas and toward the end of the war were turning it out at a rate of over 66,000 pounds per day.[2] The Allies knew how to make mustard gas in the laboratory long before the Germans used it. In fact, it has been reported that the British had considered it as a war gas in 1916. It was nearly a year after the Germans first used it, however, that the Allies were able to reply in kind with mustard gas of their own manufacture.[3]

A complicated process of manufacture means generally an expensive process. Special equipment is costly. One of the requirements of a war material is that is shall be cheap. This applies to all munitions. If the explosive or the gas is too expensive, something else must take its place. Expense is no small factor. Money is one of the important sinews of war; it may flow like water in war time, but there is a limit to spending even then. Given two agents reasonably close to each other in performance, the less expensive of the two will be used. The Germans had an excellent gas in superpalite, a compound having about the same toxicity as phosgene. During the war we were unable to make it in quantity so that it could compete in price with what we already had, so we never used it, although in many ways it was superior to phosgene.[3] Our ideal gas will not be of much use to us if it proves to be too costly. It is a cold-blooded fact, but none the less true that creating casualties is a dollars-and-cents proposition.

Regardless of expense, however, the military chemist, in constructing a new compound, is limited also to raw materials that are easily procurable in the homeland. Strategic materials—those that come from overseas and the supply of which depends upon transport facilities and the ability of the Navy to keep the sea lanes open—are barred as building blocks. Similarly, critical materials for which there is a big demand in the manufacture of other essential war products, should not be used as raw materials for the ideal war gas. We are especially fortunate in this country in our raw materials, for there are very few that enter into war-gas manufacture that we do not have immediately available. Some few, not important at present, are limited in amount. If, for example, by some stretch of the imagination, it should be found that nickel carbonyl has some use as a war gas because of the fact that it will decompose to produce carbon monoxide, we would have difficulty in getting enough nickel, which is not obtained in quantity within the United States. We would, perhaps, avoid iodine compounds since large amounts of the raw material, iodine, are not immediately available.

England had trouble in getting bromine to use in making tear gas, so instead adopted an iodine compound, ethyl iodoacetate. At the time her supply of iodine was greater than that of bromine. Since the war, processes of making bromine from sea water have increased the availability of that element.

WITH our tremendous natural resources, we are not likely to be restricted materially by raw materials in our choice of a combat chemical, but we cannot overlook the requirement of availability in making that choice. It would be very sad to base plans upon a compound only to find that a component needed in the manufacture was missing at a critical moment.

Besides the essential requirements already discussed, all of which must be

[2] "Die Chemische Waffe in Weltkrieg" by Dr. Ulrich Mueller—Berlin, 1932.
[3] "Chemical Warfare"—Fries and West, N. Y., 1921.

met by any chemical agent, there are several more which are highly desirable, and in which the *ideal* agent certainly must qualify. The war gas should be easy to transport. If a true gas, for example, it should be easily liquefiable. If the gas cannot be reduced to the liquid state readily, it would be well nigh impossible to transport enough up to the point of discharge to make an attack worth while. Enough chlorine never could have been brought up to the trenches to produce the great cloud gas attacks that were made on the Western Front by both Allies and Central Powers if it were not possible to reduce it to the liquid state and confine it as a liquid in metal cylinders. Carbon monoxide has many qualities which would make it an ideal war gas, but it is practically impossible to liquefy. It would tax the transport facilities of an army to the breaking point to get enough carbon monoxide forward. It cannot be carried in light balloons. It must be confined in heavy metal containers and these represent dead weight ineffective in the attack.

The transportation problem is a hard one in war and anything that complicates it is serious. The war gas not only should be compact, but it should be safe to transport. Anything that is difficult to confine, that leaks, that corrodes the container, is undesirable, although these defects do not necessarily rule an agent out of consideration. Corrosion, however, is a factor which limits the value of a material. Some chemicals cannot be confined in metal since they react to destroy the metal and in so doing are changed themselves. Brombenzylcyanide (CA) is an example of such a chemical. Since it corrodes steel and iron and thus loses its effect, it cannot be filled into ordinary shells as is possible with mustard gas, but must be contained in special glass or enamel-lined shells. The German T-stoff had similar properties and was placed in lead containers which fitted into the shells. This, of course, is undesirable since shell manufacture is complicated, expense is greater, and the weight of shell is increased.

STABILITY is another requirement that must be taken into account. A combat chemical is valueless if it breaks down into harmless or less effective compounds from the shock of explosion when fired, or if it will not stand up unchanged upon long storage. National defense requires that stocks of war materials be held in war reserve so that they may be immediately available in an emergency. There should be enough munitions on hand when a war starts to take up the slack before manufacturing production can meet the demands of the armed services.

The nation that has adequate war stocks is not likely to have to fight. A good war reserve is excellent peace insurance in spite of all that our pacifist friends may say to the contrary. A chemical war reserve, however, demands very stable chemical agents. Hydrogen cyanide often has been suggested as a war gas. One of the objections has been that it is not stable enough. Again, the ideal competes with mustard gas, which is highly stable. I have seen cylinders of war-time mustard gas opened recently; the agent was found to be unchanged since being placed in the cylinder in 1919.

Both hydrogen cyanide and carbon monoxide fail to meet ideal requirements in another respect. They are not heavier than air. A war gas must stay close to the ground when fired. Gases that are lighter than air are likely to be dissipated before they can accomplish their mission. True, the two cited are not much lighter than air, and if they met all other specifications would still be useful although they do fall short of the ideal in not being heavier than air.

So, finally, we are approaching the end of our requirements. If a chemical agent is found that combines all of the qualities enumerated, it will be extremely useful in war, useful enough perhaps to decide the issue for us; but for it to be perfect, there is one more hurdle. The ideal war gas should be difficult to detect. It should be colorless, odorless, and tasteless. I can think of only one substance that might possibly be used in war that meets this last requirement. That is carbon monoxide, which has no odor, no color, and no taste. Here again mustard gas makes a plea for attainment of the ideal. It cannot be detected by color in the vapor state, and in spite of its strong odor, it has the property when breathed for a minute or so of destroying temporarily the sense of smell. The smell organs become fatigued and the odor is no longer detected after a few breaths. We can't quite accept that as meeting specifications, but it is a good try. Mustard gas will continue to be used.

The quest for a perfect chemical combat substance, however, is only one of the many problems confronting the chemical warfare research establishments. The development of adequate protective equipment and the development of suitable munitions and weapons for the dispersal of the war chemicals are equally important. All these researches go hand in hand. The field is a large one, yet it represents only a part of a much larger field—the maintenance and development of the entire system of national defense. No nation may neglect any part of its scheme of defense without endangering the whole. The military problems are so many and so varied that the quest for the perfect gas may only receive its proportionate share of attention as determined by supreme military authority.

The specifications for the perfect war gas should convince us that perfection is the unattainable ideal. Progress will be made, and new and more effective compounds doubtless will be discovered, but, considering the many requirements that have been enumerated, we need not be alarmed at sensational reports of a new gas that will blot out civilization.

●

Can battleships be driven by gangs of Diesel engines of the size used in motor trucks or buses? A discussion, scheduled for January, says yes—provocatively!—The Editor.

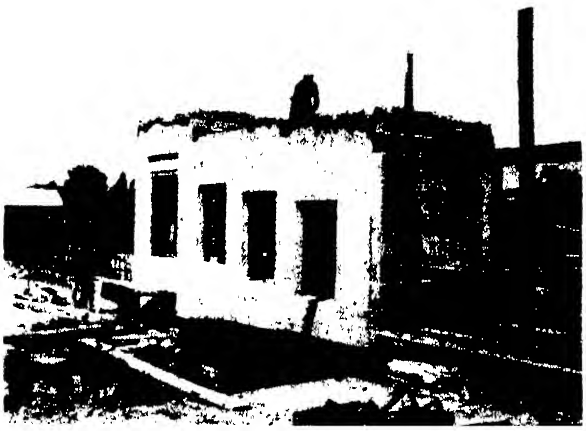
Firing a battery of gas projectors. Note cylinders in air

Another Step Toward

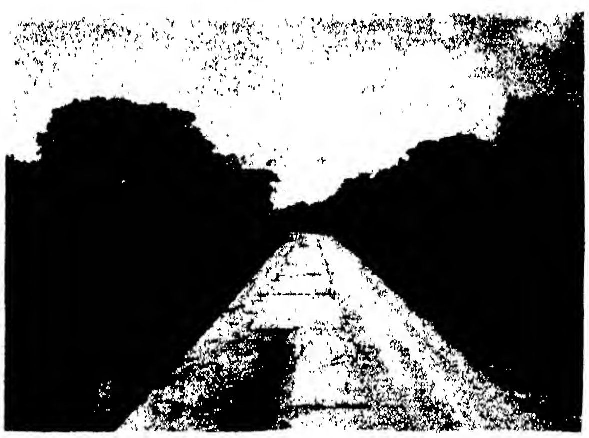
HIGHWAY SAFETY

A Planned Express-Way . . . Overhead Crossings . . . Pedestrian Subways and Overpasses . . . An Example Worthy of Attention by City Planners Elsewhere

By EARLE DUFFY



Left: One of the entrances to a pedestrian subway along the new express highway. *Below:* Two miles of the highway have been cut through a city park. The sloping banks will be landscaped. *Lower right:* A highway grade separation that is typical of the structures which will carry cross streets safely over the new express-way



IT is to be just one street with five traffic lanes, yet St. Louis' new express-way will carry two and a quarter times as many vehicles as the ordinary wide boulevard. The new artery, a part of a super-highway 38 miles long, will demonstrate, claim its builders, that motor travel can be made safe as well as rapid. The project is being watched with interest by other cities, cursed, like St. Louis, with traffic troubles.

Three and a half miles of this new highway leading to downtown St. Louis is within the city limits. One mile of the artery is to be depressed, with cross streets carried overhead. Not a single street intersection at grade level will be encountered in the section within the city. Four special pedestrian subways and overpasses and one equestrian subway are the finishing touches that make this a roadway really designed for the automobile. The project is well under way, and work will continue throughout the winter.

The wide right-of-way for the depressed section, cut right through where homes, apartment buildings, and shops once stood, will permit of gently sloping banks along the highway, which are to be sodded and landscaped.

The entire project is called Traffic Relief 40 which extends westward 38 miles from downtown St. Louis, to connect with U. S. 40 and U. S. 61. At the edge of the city two miles of an existing five-lane highway will be utilized. Then comes 13 miles of four-lane concrete and six miles of three-lane pavement, all over new right-of-way. This carries the road to the Missouri River where a new bridge will be built. The road then continues three lanes wide to Wentzville. All busy intersections will have highway grade separations.

The express-way crosses Missouri 77, a wide belt-line highway that encircles the city five miles out from the city limits. Consequently the express-way will be of great utility to tourists and through travelers. They may approach the city on any one of the several roads, strike the belt road and follow it to the express-way. This will carry them to downtown St. Louis in a few minutes, as against the 45 minutes now required over the devious routes that must be followed.

The express highway is the only one of its kind outside the New York City area. There, a depressed highway leads from the Holland Tunnel through Jersey City. However, that a city of the size of St. Louis, less than a million population, should build such a modern artery leads to the conjecture that other cities, both larger and smaller, may soon embark on projects of a similar nature. St. Louis engineers have expressed the opinion that only through the construction of elevated or depressed roadways can real driving comfort and safety replace the widespread congestion with its attendant dangers which are so characteristic of many of the so-called "super" highways that have been built during the past few years, and are still being built.

OUR POINT OF VIEW

The Trade Mark Scarecrow

NOT all pirates are on the high seas. Not all the racketeers are to be found in the kidnapping and bootlegging business. In fact, the once infant racket has grown to such a stature in our modern commercial world and has raised such a family of not-so-little brothers that today rackets are to be found in the most unexpected places.

One of these big brother rackets now stalks the halls of our various State Legislatures. It has been aptly named "The Registration Racket."

For the trade-mark owner engaged in interstate commerce, Federal registration of trade marks is desirable. Registration, particularly under our Federal Trade Mark Act of 1905, is highly advisable. Such registration has many benefits. A certificate of registration under the Law of 1905 is prima facie evidence of ownership. It gives the registrant the rights to sue in Federal Courts regardless of diversity of citizenship. By taking advantage of the provisions of the Law of 1905 a registrant may prevent the importation of goods bearing infringing marks. Other procedural advantages are likewise to be gained by Federal registration.

What is not realized, however, and at times only vaguely understood, is that ownership of a trade mark in this country arises *out of use* and not out of registration. In South America and some of the European countries, the so-called Continental system is in effect which makes registration a prerequisite to ownership and results in a race for registration and permits piracy of trade marks by unscrupulous competitors and others who register marks in the expectation that the otherwise rightful owner will be forced to buy them off by purchasing the registration.

The trade-mark racketeer favors some such system. He is not interested in advocating Federal registration. That means but one registration. He would like to multiply his "service" by forty-eight. So he advises registration in all of the States—he, of course, to handle the business of securing registrations. Owners of trade marks are approached and advised that they will lose their rights to others unless they register in the individual states.

The self-styled trade-mark service specialist is rarely ever a lawyer or patent attorney. He comes as close, however, as he can to the unlawful practice of the law, trying always to keep within bounds but frequently overstepping the legal limits. He sometimes conducts an advertising campaign filled with misleading statements. He usually begins by falsely representing that trade-mark ownership may be *created* under existing state statutes by *state registration*. He frequently resorts to intimidation—the usual weapon of the racketeer. He advises as to the legal effects of statutes and decisions—perhaps "misleads" would be a more accurate word. Many good and valid trade marks have been registered, of course, in the various states but their validity is predicated upon wholly collateral facts.

The trade-mark owner is becoming educated. Much has been written recently on this subject. The Association of the Bar of the City of New York, as early as 1929, published a bulletin prepared by the Association's then Committee on Trade Marks and Unfair Competition entitled "Warning against misleading advertisements of Trade Mark Specialists." As late as December of 1934, the current Committee of the Association republished this bulletin.

Recognizing that trade-mark owners are gradually coming to the realization that existing state statutes do not support the extravagant claims made for them, our self-styled specialists determined upon a bold move and almost carried it out. In certain states they have fostered and vigorously supported proposed new trade-mark legislation which had been recently introduced as revenue measures. These proposed bills would make registration in a given state the sole determinant of ownership in trade marks. Consequently, the first to register would become the owner of the mark within the state in question regardless of whatever might be the property rights of others in the next state or elsewhere.

These bills propose to set up elaborate machinery comparable to the procedure followed in connection with the registration of trade marks in the United States Patent Office. In these times of financial stress, frantic law makers seeking to add to the states' revenues have listened attentively to any means which will provide additional and sorely needed funds. However, as this is being written the jokers in the deck have been discovered and Maryland, Nevada, New Jersey and New York have apparently rejected bills of this nature which had been proposed.

It is to be hoped that the legislatures of other states, in addition to those named, will take similar action in refusing to enact such vicious legislation and that trade-mark owners will not permit themselves to be unduly alarmed by those who advocate this bugbear of state registration.

Agricultural Imports

A STRANGE thing has been happening to our foreign trade. While the United States has been recapturing certain markets abroad—notably in Pan-America, as discussed some months ago in these columns—we, too, have been captured. With our backs against our tariff wall which functions to restrain much of the trade that is most proper for us, we have been content to sit and smugly contemplate the operation of experiments which seem but to encourage "improper" trade. The results are startling.

For the first eight months of 1935, the excess of exports over imports was 27,277,000 dollars as compared with 259,124,000 dollars in the same period of 1934. But that is not the worst. Imports of food products, of which there should be adequate supplies from our own vast farms, have risen at a shocking rate while exports of the same commodities have fallen. Here are a few samples:

IMPORTS	**1935**	**1934**
Wheat (bu.)	*9,801,715*	*557,603*
Lard (etc.)	*10,758,779*	*147,361*
Butter (lbs.)	*21,826,263*	*436,695*
Corn (bu.)	*31,822,886*	*371,731*
Canned Meat	*49,770,402*	*26,215,757*
EXPORTS	**1935**	**1934**
Wheat (bu.)	*142,173*	*16,618,769*
Lard (etc.)	*86,235,889*	*369,604,047*
Butter (lbs.)	*500,881*	*965,776*
Corn (bu.)	*154,307*	*2,122,114*
Canned Meat	*9,115,899*	*11,049,454*

Of course we have done somewhat better with other commodities but the above figures tell a significant story. Most people believe there should be a natural exchange of goods between nations—each nation exporting what it can best produce and importing those products it lacks or cannot make. In the United States, there should be no dearth of agricultural and dairy products. The reader may, therefore, draw his own conclusions from the figures quoted above. It would, indeed, be bitter irony if the farmers, traditionally inimical to the protective tariff, should suddenly raise a howl for a tariff to protect their farm products so they can continue cutting production and raising prices!

ENERGY FROM MATTER

By E. U. CONDON
Associate Professor of Physics, Princeton University

THAT the readers of this magazine desire the inclusion of at least some stiffer, less elementary articles than those which have appeared in the past few years was clearly indicated by the enthusiastic response to our "feeler" for reader reaction which accompanied Professor Condon's article in the August number. Except for two negative votes—one from a Missourian who said it was then too hot to think very hard, and one from a man who asked us, instead of articles on physics, to publish articles by G. B. Shaw (!)—every letter contained highly favorable reaction to the inclusion of harder articles in the magazine, and we take this opportunity to thank the writers of many valued and detailed comments on the magazine's policies for their letters. Next month there will be a third article by Professor Condon.
—*The Editor*

THIRTY years ago Einstein announced the principle that mass and energy are equivalent. That is, the more energy a body contains, the greater its mass or inertia. The amount of energy equivalent to a given mass, he said, is obtained by multiplying the mass by the square of the velocity of light. This means, since that velocity is 3×10^{10} centimeters per second, that one gram of matter is equivalent to 9×10^{20} ergs of energy.

On this view matter is a latent or "frozen" form of energy. If we could convert the energy into a useful form like kinetic energy or heat energy or electrical energy, enormous quantities would be available from small amounts of matter. All this has been the object of much speculative peering into the future, sometimes with pretty fantastic results. Instead of doing that, let us review carefully just what sort of evidence has recently come to light showing that Einstein's principle is correct.

Before doing so, however, let us first get a better idea of the amount of energy frozen in matter in terms of more familiar units than the gram and the erg. There are 453 grams in a pound, so conversion of a pound of matter into energy would give 4.07×10^{23} ergs of energy. The erg is a very small unit: there are 3.6×10^{13} ergs in one kilowatt-hour. Dividing out we find that the energy latent in matter is *11.3 billion kilowatt-hours per pound.* This is more than a billion times greater than the energy made available by the burning of fuels. A typical value of the heat available in burning petroleum products is only 6 kilowatt-hours per pound.

The relative smallness of the energy change in combustion, and other chemical reactions, accounts for the negative result of all experiments in which attempts were made to detect a change in weight of the substances transformed in a chemical reaction. As the energy change on combustion is only about a billionth of the whole latent energy, the change in weight in going, say from gasoline plus oxygen to the combustion products carbon dioxide and water, will amount to only about one part in a billion. No known methods of weighing can be carried out to this precision, so it is hopeless to try to check Einstein's principle in this way.

FROZEN or unavailable energy always excites popular imagination, since the unavailability is a challenge to everyone to make it available. It is easy to think of other vast quantities of unavailable energy, but these are not in such a concentrated form as that latent in a mass of matter. For example, if one could slow down the earth's rotation on its axis so that the day became only one-billionth of a second longer than it now is, the energy would be diminished by 1,240,000,000 kilowatt-hours. This is comparable with the energy latent in an ounce of matter, but this energy is spread out over the whole mass of the earth: it is an attribute of 6×10^{21} tons of matter instead of one or two ounces. Think of the difference in concentration!

Such playing around with the conversion factor between mass and energy may provide striking examples of the vastness of the energy content of matter, but it tells us nothing about how to release that energy. What we have now to consider is the experimental evidence for the reality of the conversion. As yet there is no recorded instance in which the whole mass of an atom was converted into energy of motion or of radiation. The amount of energy associated with the motion of individual cosmic ray particles is about right to correspond to such processes, however. This naturally gives rise to the speculation that cosmic rays originate in this way, and stimulates investigation concerning cosmic rays. But, so far, nothing is known about how they originate.

The kind of evidence we have for mass-energy conversion is based on the energy changes involved in the atomic transformations studied in nuclear physics. In these the total mass of the products may fail to check with the total mass of the initial atoms by about one part in a thousand. These very small mass changes have then to be correlated with the energy changes occurring, to see whether a diminution in mass means a gain in energy and vice versa—and, of course, to see whether

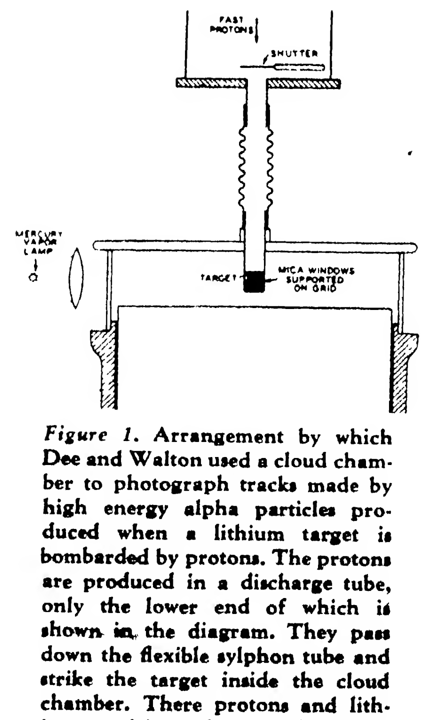


***Figure 1.* Arrangement by which Dee and Walton used a cloud chamber to photograph tracks made by high energy alpha particles produced when a lithium target is bombarded by protons. The protons are produced in a discharge tube, only the lower end of which is shown in the diagram. They pass down the flexible sylphon tube and strike the target inside the cloud chamber. There protons and lithium nuclei combine to form two helium nuclei which rush out through the mica windows into the cloud chamber. The bottom of the chamber is a piston which can be suddenly expanded, causing the moist air in the chamber to cool. This makes water droplets form on the ions formed in the moist air by the fast helium nuclei, thus rendering their tracks visible. The top of the chamber is of glass and the tracks are photographed from above**

How Einstein's Principle is Verified . . . Stupendous Energy Revealed . . . But Unavailable Because of Low Efficiency of Transmutation

the conversion factor between mass and energy is that given by Einstein.

Evidently this calls for very precise measurement of the atomic masses and a close analysis of the energy changes involved. Although recent research has provided numerous examples in which these mass-energy conversions are studied, let us confine our attention to one specific case in the interests of clarity. We consider the atomic transmutation that is symbolized in the equation $Li^7_3 + H^1_1 \rightarrow He^4_2 + He^4_2 +$ kinetic energy. This has recently been studied very carefully by Oliphant, Kempton, and Rutherford in the Cavendish Laboratory at Cambridge University in England.

THIS abstract equation refers to what happens in an experiment of the following sort: A vacuum discharge tube is arranged which contains an electric arc burning in hydrogen at one end. In this arc hydrogen molecules are dissociated into electrons and protons. The proton is symbolized by H^1_1 in the equation, H being the chemist's symbol for hydrogen, the subscript 1 meaning that the particle has unit electric charge (same as that of an electron) and the superscript 1 meaning that its mass is *approximately* 1. (We shall have to speak of the exact mass later.) The end of the tube containing the arc is put at a positive potential of several hundred thousand volts with the aid of an auxiliary power supply. The other end of the tube is placed at ground potential and in it is placed a small target of lithium, atoms of which are symbolized in the equation by Li^7_3, since the lithium nucleus has three positive charges and a mass *approximately* 7.

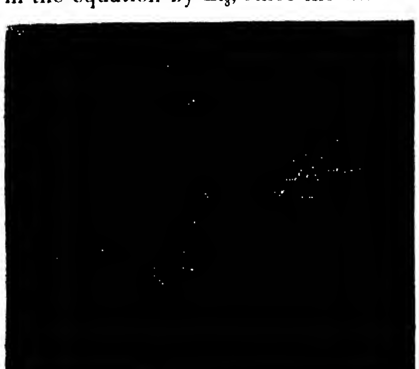


***Figure 2.* A large number of the tracks of fast alpha particles as obtained with the apparatus diagrammed in Figure 1. The black area in the center from which the tracks radiate is the end of the discharge tube which contains the target**

Under the influence of the electric field applied to the tube a current of the positive hydrogen ions is drawn out of the arc and accelerated down the tube. With suitable design the ions of hydrogen will be kept focused in a narrow beam and can be made to strike a target less than a quarter of an inch in diameter. The energy of motion acquired by the ions can be simply calculated from the known voltage used to accelerate them and their charge.

Striking the target, most of the hydrogen ions go into the lithium and lose their energy in encounters with the electrons in it without getting close enough to the nucleus of a lithium atom to have any effect. This is because the distance apart of the nuclei is some 10,000 times their size, so the chances of a direct hit are very small. This accounts for the low efficiency of the process being studied—if a way could be found to take aim at individual nuclei instead of firing at random, the study of these processes would be greatly simplified.

WE are interested only in the small number of the high speed protons which do make direct hits. They mix intimately with the internal structure of the lithium nucleus for a time estimated at 10^{-21} second (since they move with a speed of 10^9 centimeters per second and the nucleus is only 10^{-12} centimeters in diameter). The stuff is there to make a nucleus having a charge of 4, so it would be beryllium, having a mass approximately 8. But this kind of beryllium atom is unknown—the kind occurring in nature is of mass 9. So, instead, the intimate mixture of Li^7_3 and H^1_1 stuff falls apart, giving two nuclei of helium of charge 2 and mass approximately 4 each. Being both positively charged they repel each other, are set in rapid motion, and so rush apart with kinetic energy.

How do we know this? In several ways. The high speed helium nuclei, commonly known as alpha particles, have enough energy to penetrate thin windows of mica placed near the target in the discharge tube. If the windows are surrounded by a Wilson cloud chamber then photographs may be made of the ionization tracks made by the alpha particles as they go through the chamber. This was done in Cambridge by Dee and Walton. Figure 1 is a line drawing of the apparatus near the target end of the discharge tube and Figure 2 is a beautiful example of a photograph obtained in this way. Here we see many tracks produced by the alpha particles which have started at the target and passed out into the chamber through the thin mica windows. In Figure 3 we see another photograph of the same kind with but two tracks. These are due to two alpha particles which undoubtedly were formed in the same disintegration process and rushed out simultaneously in opposite directions. Actually this second picture was taken with the new heavy hydrogen supplying the ions for bombardment of lithium, and corresponds to transformation of the lighter isotope of lithium of mass approximately 6 by the reaction $Li^6_3 + H^2_1 \rightarrow He^4_2 + He^4_2 +$ kinetic energy. The alpha particles formed this way have considerably more energy than those formed in the reaction we have been considering—that the tracks are shorter in Figure 3 than Figure 2 is due to the fact that in making Figure 3 thicker windows were deliberately used to slow down the particles and keep their whole path within the camera's field of view.

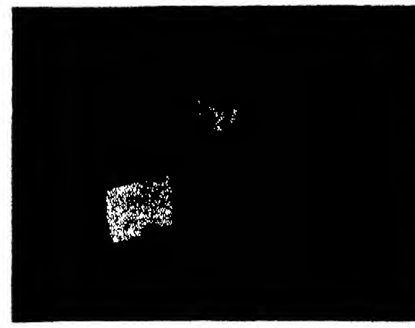


***Figure 3.* This is a photograph similar to Figure 2 except that the proton current was made much weaker to avoid getting a large number of tracks in one picture. In this way it is found that the tracks always come in pairs going in opposite directions from the source, corresponding to the formation of two fast moving helium nuclei when lithium is bombarded with hydrogen ions of high energy**

FROM the length of the track the kinetic energy of the alpha particles is obtainable, allowance being made for the stopping power of the thin windows. The relation between track length or *range* and energy is known from other experiments made with alpha particles from naturally radio-active substances. There are other, more accurate, ways of measuring the range than from the cloud chamber photographs, and with one of these Oliphant, Kempton, and Rutherford found the range of the alpha particles to be 8.29 ± 0.03 centimeters in air, which corresponds to an energy of 13.7 microergs (millionths of

(*Please turn to page* 339)

THE BREATH

By WILLIAM H. EASTON, Ph.D.

Photo by Ewing Galloway

Smoke is poisonous, but firemen can't keep away from it. Hundreds are felled by smoke each year

WITH siren screaming, a red fire department automobile dashed up the street and came to a sudden stop before a small apartment house. Two husky firemen, bearing something that looked like a suitcase, sprang from the car and disappeared into the doorway.

A crowd collected at once and, gazing excitedly at the windows of the house, waited for the crash of glass and the tell-tale streamers of smoke.

But nothing happened. No smoke, no fire, no further excitement. Presently the firemen reappeared, and their car bore them out of sight.

"False alarm!" muttered the crowd, disappointed.

But it wasn't a false alarm.

In one of the apartments of the house which the firemen entered, a young man had been sitting beside a closed door, listening, with nerves strained to the utmost, for the thin, high-pitched wail that announces a new life.

Unexpectedly, the door was flung open, and a man thrust his head out.

"Call Greenwood 6-4322, quick!" he commanded. "Tell them to hurry here baby case!"

"But doctor—" said the young man.

"Step on it!" shouted the doctor and slammed the door behind him.

It was that call that had sent the red car flying through the streets and brought the firemen pounding up the stairs.

Without a word, the physician motioned to the newcomers. Without a word, they entered the bedroom.

For a moment, the bewildered young man could not see what was going on. Then someone moved aside, and he caught sight of a tiny form lying on the bed with a little mask on its miniature face. One of the firemen was working over it, and the other was beside the bed, busy with the apparatus they had brought. The doctor, catching sight of the young man, closed the door.

Five minutes—ten minutes—passed in silence. Then the listener heard the doctor's voice. "Okay, boys," he said, "that's done it."

The door opened, and the doctor called, "Come in, Mr. Brown, and thank these men. They have saved your son's life."

JOBS like this are all in the day's work of every well-organized fire department. Daily, all over the country, specially trained firemen are answering just such calls—calls for the breath of life. Sometimes it is to help a new-born baby start breathing properly. Sometimes it is to revive victims of illuminating gas, drowning, or electric shock. Sometimes it is to ease the distress of those suffering from pneumonia, asthma, and other suffocating diseases. These men of the rescue companies of the Fire Departments have the breath of life, and it is freely at the service of anyone needing it.

Many others are now also rendering this service. Every modern hospital has the necessary apparatus. In most of the larger cities, including New York, the police departments take care of the majority of calls of this nature. Everywhere, electric light, gas, oil, and other industrial companies have trained and equipped rescue squads which are ready to serve the public in case of need. But for the country as a whole, reliance is placed chiefly on the fire departments for the equipment, the trained personnel, and—perhaps most important of all—the rapidity of action that is vital when someone is dying for lack of air.

Statistics for the country as a whole are lacking, but a medical official of the New York Police Department has estimated that about 12,000 die annually in the United States from suffocation due to drowning, gas poisoning, electric shock, and so on, and that from 40,000 to 50,000 are rescued from a similar fate by the prompt application of remedial measures.

In fact, if there is a spark of life left in a victim of asphyxia, and he is not otherwise seriously injured, the chances are better than 10 to 1 that a trained rescue squad will bring him around.

Smoke, to the average citizen, is one thing; to the fireman, it is something quite different. The layman, thinking of smoke in terms of his experience, considers it, in itself, relatively harmless; the fireman, as the result of his experience, knows that any kind of smoke may carry a deadly menace.

A boy, rescued from the burning steamship, *Morro Castle*, thought there was something very strange about the "bitter, black smoke" that rolled down upon him from an upper deck, and he is reported as testifying on the witness stand that this smoke "did not smell like ordinary smoke, not like wood smoke at all, but had a peculiar biting quality."

But the evidence presented at this inquiry goes to show that this smoke was the result of the burning of such ordinary materials as woodwork, rugs, draperies, furniture, and bed clothes, so there was nothing unusual about it at all. The lad was in direct contact with *real* smoke for the first time in his life, and it surprised him.

AS a matter of fact, smoke consists of two parts—visible and invisible. The visible part of smoke consists of exceedingly fine particles of carbon, or soot, together with certain tarry and oily substances. These particles, suspended in pure air, form what the average person regards as smoke. When breathed into the lungs, they are somewhat irritating but are not asphyxiating to any considerable degree. Hence the general impression that smoke is not particularly harmful.

But smoke of the kind that rolled down upon the boy on the *Morro Castle*, and fills burning buildings, contains invisible gases as well as visible particles —and these gases the fireman has good reason to dread. Strangely enough, it is

OF LIFE—AT YOUR SERVICE

Smoke, to You, is One Thing — to the Fireman Quite Another...He Takes It Seriously... Knows Its Dangers . . . A Pleasant Death, Anyway

only in the past year or two that we have gained a clear conception of the composition of the gases in smoke.

On May 15, 1929, a fire broke out in a Cleveland hospital where 8500 pounds of X-ray films were stored. One hundred and twenty-four people died in this disaster, of whom the great majority were killed by smoke and not by heat or flames. This led to an investigation of the kind of gases given off by burning film, and this, in turn, led to a study of the gases given off by the combustion of a variety of common materials. This work was carried out by Dr. John C. Olsen and associates, of the Polytechnic Institute of Brooklyn.

In conducting these experiments, Dr. Olsen used a small building consisting of a single, asbestos-lined room equipped with facilities for drawing off gases. In this room he burned newspapers, wood, excelsior, gasoline, rubber insulation, woolen goods, and natural silk. The gases formed by both the slow (or smoldering) combustion and the rapid burning of each of these materials were drawn off and analyzed.

When all of these substances were burned, Dr. Olsen found that the resulting smoke contained irritants such as acids or ammonia, volatile organic compounds, many of which act as anesthetics, the comparatively harmless carbon dioxide, and the deadly carbon monoxide. In addition, he found in the smoke given off by burning rubber, woolen goods, and natural silk, surprisingly large amounts of the most poisonous gases known to man—hydrocyanic, or prussic acid, and hydrogen sulfide.

As a killer of man, carbon monoxide stands at the head of the list of these smoke gases. Formed by the *incomplete* oxidation of carbonaceous material (carbon dioxide is the *complete* oxidation product), it is present in the smoke of practically all fires. It is also found in artificial illuminating gas, in the "coal gas" that issues from coal stoves and furnaces, and in the exhaust of automobiles, and it is often given off by improperly regulated gas and oil stoves.

It is difficult to conceive of a more insidious enemy than carbon monoxide. It poisons us, states Dr. Yandell Henderson, of Yale University, in a report to the Committee on Poisonous Gases of the American Medical Association, because it combines over 200 times more readily with the red coloring matter of our blood than does the life-giving oxygen. Hence, when we breathe air containing only a few tenths of one percent of carbon monoxide, our blood absorbs it eagerly and becomes charged with it. Oxygen is then excluded, and we die of what may be called "internal suffocation."

Photo by Dana B. Merrill

The inhalator supplies a mixture of oxygen and carbon dioxide for use in the treatment of cases of asphyxiation

Carbon monoxide is tasteless, odorless, and colorless; we breathe it without knowing it. And usually "carbon monoxide gives no warning," says Dr. Henderson. "The first effect is often a sudden muscular weakness which causes the victim to fall to the floor and renders him helpless. Unless he is discovered in time, unconsciousness soon follows and then death."

This, then, is the gas to which firemen are constantly exposed. But hydrocyanic acid and hydrogen sulfide—the other two highly toxic gases found by Dr. Olsen in the smoke from the burning of certain common materials—are even more poisonous than carbon monoxide. Death may result from a few breaths of either.

In fact, such quantities of hydrocyanic acid and other poisons are produced by burning silk and wool that Dr. Olsen emphasizes the special danger of inhaling smoke from burning garments. Many persons, he points out, undoubtedly lose their lives at fires because their clothes ignite and they are then enveloped in toxic gases.

THE moral is—Beware of smoke! If, for example, you find smoke pouring out from behind the door of a clothes closet, *don't open that door*. Clear the house of people, and call the fire department, if possible. If there is no fire station in the vicinity, don't attack the fire yourself until you have provided yourself with plenty of fresh air by opening doors and windows, are assured of a ready retreat (and preferably by more than one route), and have at hand ample facilities for extinguishing the blaze. Be especially careful not to let the smoke envelope you when you then open the closet door.

Also, if it is humanly possible to avoid doing so, never rush out into a smoke-filled hallway. Everyone should know that the safest plan to follow when caught in a burning building is to close the door of the room you are in and *get out by the window*. If escape this way is impracticable, throw the window open and make as much noise as possible.

"Most people who perish in burning buildings die from smoke rather than flame," an officer of the New York Fire Department told the writer.

There is beneficence in this: Death by smoke is quick, and, according to Dr. Henderson, painless.

"Of course, firemen understand the dangers of smoke and know how to protect themselves," said the writer, somewhat naïvely.

"Protect themselves!" was the answer. "Say, listen! When those boys are ordered into a burning building they

go in, and they stay in until they are ordered out—or are carried out. There's only one way to protect yourself from smoke, and that's something a fireman can't do—stay away from it."

No serious and avoidable risks are taken, however. Where the atmosphere is known to be too "thick" for human safety, trained men with gas masks are sent in.

But firemen do not wear gas masks regularly, and a hundred or more are overcome by smoke in every large city every year. The treatment of these cases is one of the routine jobs of the fire department rescue companies, so they have become extraordinarily efficient in this service, to the benefit of their public as well as their fellows.

To aid them in this work, modern science has developed an ingenious instrument known as an "inhalator." This device administers copious supplies of oxygen to the victim of suffocation. Some years ago dependence was largely placed on mechanical breathing devices which pumped oxygen in and out of the lungs by applying positive pressure and a vacuum alternately. In unskilled hands, however, devices of this kind may injure the lungs or force fluid into them, thereby increasing the chances of pneumonia, and their use by laymen is not recommended by medical authorities. The inhalator, on the other hand, accomplishes the desired results without the use of moving parts and without forcing gas mechanically into the lungs. It is accepted for rescue work by such bodies as the Accident Prevention Committee of the American Gas Association and the Council on Physical Therapy of the American Medical Association.

THE inhalator as now used is due to the work of Drs. Henderson and H. W. Haggard, of Yale University. These investigators knew that carbon dioxide is one of the regulators of our rate of breathing. As they point out in their book, "Noxious Gases," we breathe more rapidly whenever carbon dioxide tends to accumulate in our lungs, thereby getting rid of the excess, and we breathe more slowly when the carbon dioxide content of our lungs tends to go below normal, thereby permitting a normal amount to collect. That is why we breathe more rapidly after physical exertion; we are getting rid of the excess of carbon dioxide formed in our bodies as the result of our efforts.

In studying various methods for the treatment of suffocation, Henderson and Haggard decided to make use of this principle and tried the experiment of administering oxygen gas containing about 7½ percent of carbon dioxide to carbon monoxide victims. As soon as the gas mixture containing carbon dioxide enters the lungs, breathing is immediately stimulated. A patient, who may be just drawing feeble breaths, begins at once to breathe more rapidly and deeply, and thus inhales large quantities of the life-giving oxygen.

This mixture of oxygen and carbon dioxide is now universally used in the treatment of asphyxia. The inhalator, by means of which the gas mixture is administered, is a very simple piece of apparatus. Its most important part is a cylinder containing "carbogen" under 2100 pounds pressure and equipped with a reducing valve and two pressure gages. Rubber tubing connects the reducing valve with a collapsible "breathing" bag, and a length of flexible hose connects the bag with a face-piece which can be fastened over the victim's nose and mouth. The whole is contained in a small case and is readily portable. The equipment is ready for instant use, it is easily operated, and it is safe in the hands of those without medical training.

When anyone is overcome by smoke or gas, he is carried out into the open air and wrapped in blankets. The application of artificial heat is very desirable, and many rescue squads make a standard practice of filling hot-water bags from the radiators of their cars for this purpose. The face-piece of the inhalator is attached to the victim, and the gas mixture turned on.

If the victim is still breathing, the stimulating effects of the gas mixture are evident at once. He takes deep breaths of the gas and, under favorable circumstances, soon regains consciousness. If breathing has ceased, artificial respiration is immediately employed, which draws the gases into the lungs and stimulates natural inhalation.

Similar treatment is employed for practically all cases of suffocation for, in all, resuscitation depends upon providing the body with an adequate supply of oxygen. In cases of drowning, suffocation by certain gases, and electric shock, where the nerve centers controlling the breathing muscles have been paralyzed, success is usually attained when the victim starts breathing. But with carbon monoxide poisoning, the blood is literally saturated with the poison, and this must be removed in order to insure recovery. Fortunately oxygen will displace carbon monoxide in the blood stream if it is supplied copiously. Hence in such cases, treatment is continued until the blood stream is brought back to normal.

OUR first line of defense against carbon monoxide poisoning, and other forms of suffocation, is to teach as many people as possible how to apply artificial respiration. Experts, naturally, are not apt to be around when cases of suffocation are discovered, and, quick as firemen, police, and physicians are to respond to emergency calls, they may arrive just too late. A few minutes of artificial respiration in the interval before competent help appears may make all the difference between life and death. As a matter of fact, many people today owe their lives to the training in this method given to Boy Scouts and others.

Our second line of defense is the inhalator. The number of these efficient and easily operated devices available to the public is rapidly increasing, not only through regularly organized rescue squads but also through industries. An ever growing number of industrial companies are standardizing on inhalators as part of their "safety-first" equipment.

Behind all, of course, stands the physician. Mobilized in time, these three defenses are sufficient. Therefore, everyone should know where, in his community, he can look for first aid to the suffocating—whether to fire department, police department, public utility, or industrial company. Then, in need, he should summon that aid first, and then call a doctor.

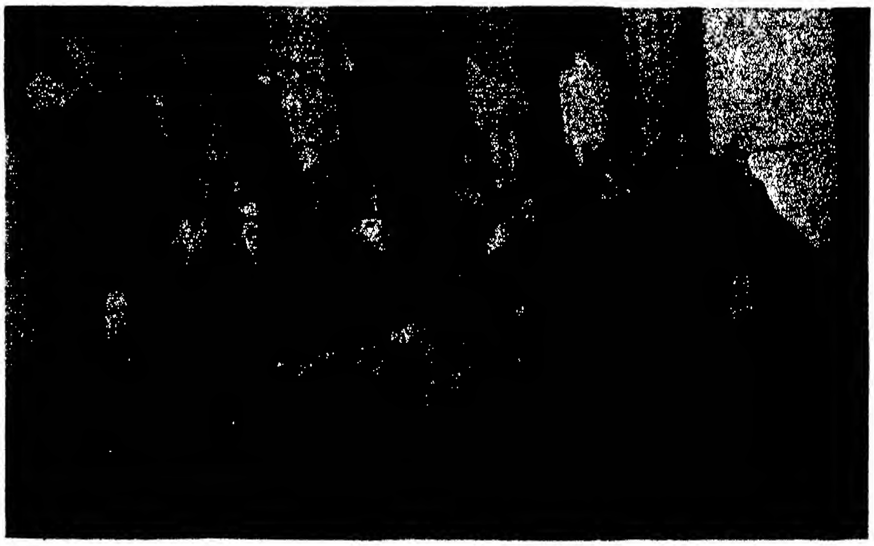


Photo by Dana B. Merrill

Saved by "The Breath of Life"—firemen revived by the inhalator

PERPETUAL ICE IN A LAVA BED

By A. P. PECK

ONE of the outstanding curiosities of the western United States is the Perpetual Ice Cave of New Mexico, located in a lava bed. The well-known fact that lava begins its existence as a molten mass lends a hint of the mysterious to the 25,000 cubic feet of solid ice some 60 feet below the surface of a geologically recent extrusion of lava. Furthermore, the gross volume of the ice is apparently the same throughout the changing seasons.

For an explanation of the existence of this bank of ice, it is necessary to go back to the formation of the lava, and to keep in mind the natural laws of insulating materials and circulation of air.

Basaltic lava, after it is ejected from a volcano, cools and solidifies. The cooling of the surface exerts great pressure on the still molten lava below, and the gases expelled from the slowly hardening stone make the mass as porous as a sponge. Also, tunnels or "volcanic tubes" are formed below the surface, the roofs of which frequently collapse forming a volcanic "sink." It is in such a "sink" that the Perpetual Ice Cave formed. Fallen stone and rubble effectively choked the tube except for a single vent which permits circulation of air from subterranean areas of the lava bed.

THE porous mass of the lava serves as an excellent insulator and, accordingly, when the great mass of lava has once been thoroughly chilled—to a point perhaps many degrees below zero, Fahrenheit—variations in surface temperatures can have little effect on the bulk of the stone. The lowest temperature reached in the most severe winter in the history of this region probably yet lurks in the remote depths of the lava deposit.

Circulation of air, warmed by the sun at the surface of the lava bed, will draw chilled air from the frigid depths through cracks and faults in the basaltic mass. Since the air thus drawn from below is considerably lower than freezing temperature, moisture seeping downward from the surface of the bed becomes ice when it encounters the cold draft. The deposit of ice thus formed blocks the passage of the cold air until sufficient melting temporarily reopens the flue. Thus the principles of insulation and circulation combine to create perpetual ice at a point where, lacking the presence of moisture, a constant blast of cold air would certainly issue from the depths of the lava bed.

The bank of ice in the cave is of aquamarine color, banded with dark horizontal stripes. It is believed that the greenish-blue coloring is attributable to pollen from nearby forests of yellow pine, which is blown by the wind to the depths of the cave with the surface water. The dark lines were formed by similarly deposited layers of dust and volcanic ash.

That the cave has been known to man for centuries is evidenced by the presence of the ruins of prehistoric Indian dwellings, as yet unclassified, on the surface of the lava flow.

The Perpetual Ice Cave is located in western New Mexico, about 25 miles from the town of Grants. It is reached by means of an improved road through El Morro National Monument and the Indian town of Zuni to the city of Gallup.

WIDE SPECTRUM LINES AND

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THERE are two stages of success in the solution of a scientific problem. Success in the first means that, knowing the facts by observation, we are able to interpret and explain them upon general principles. Success in the second would signify that, starting with the general principles alone, we could predict the facts themselves. Perfect success of the latter sort is hardly attainable. We are sometimes in a position to say: "If there are any objects of this sort, they will have such and such properties." But to say: "There actually will be so many objects of the kind in such and such positions," is too much to expect.

With this limitation, it may fairly be claimed that astrophysics is now advancing to the second stage of success.

We can not only explain the major properties of the stars in terms of those of atoms: Starting with the general properties of atoms, and the law of gravitation, we can now say: "If there are masses of matter scattered through space, only the large ones (say 100,000 times as massive as the earth or more) will be hot enough, inside and outside, to be visible at the distances measured in light years"—and, following Eddington, we can predict about how bright a star of given mass will be. To be sure, our success is incomplete—given the mass, we can predict how bright it will be, but not how big. But it is very probable that, when we know more than we do now about atoms, we will be able to predict this too.

But how will these hot luminous bodies *look?* If we mean only their appearance to the eye, the answer is trivial—like mere points of light. But if we extend our meaning to inquire how the stars' light will appear when analyzed by a spectroscope, we really have something to answer.

ELEMENTARY theory shows that the spectra will be continuous and crossed by dark lines, revealing the composition of the stars' atmospheres. Going a little further, we find that the metals will show up in the cooler stars, and the permanent gases in the hotter ones—which is an old story now.

What of two stars of the same temperature, but differing in real brightness? Can we distinguish their spectra, and if so, how and why?

How this can be done was determined 20 years ago by Adams and his colleagues at Mt. Wilson, by studying the spectra themselves. Certain lines were stronger in the very luminous giants, others in the faint dwarfs, and we all know how this discovery has been utilized to find the distance of thousands of stars. Why the lines behaved as they did was a harder problem; but, thanks to years of co-operative investigation, this, too, is substantially solved.

If we set side by side the spectra of the sun and of a giant star like Gamma Cygni, which gives out more than a thousand times the sun's light but is of substantially the same color and temperature, we will find that many of the lines are stronger in the spectrum of the latter, while others are nearly equal in the two. The star, being so much brighter than the sun, and yet no hotter, must be much larger—probably 40 times the sun's diameter. It may have a dozen times the sun's mass but the force of gravity at its surface can hardly be 1 percent as great as the sun's.

IN consequence, its atmosphere must be far more extended than the sun's. At a depth where the same quantity of matter lies above a square mile, the pressure will be only 1 percent as great. This low pressure will have two consequences. First, it will increase the proportion of atoms which have lost an electron and become ionized—another well-known effect. Secondly, it will make the gas more transparent.

This may seem strange, when it is recalled that the haziness in a star's atmosphere, which limits the depth down to which we can see—or from which we can directly receive the outcoming light—is produced almost entirely in the presence of electrons and charged atoms (ions). Should not the percentage of these make the atmosphere hazier? But this elusive fog depends not on the mere presence of these electrified particles, but upon their interaction with one another—upon the number of times per second that an electron hits an atom or comes close to it. The more rarefied the gas, the less likely this is to happen, and hence a column of gas containing a given number of ions and electrons will be more hazy, the more it is compressed (bringing the particles together), and conversely, clearer, the more it is expanded.

At the low atmospheric pressure in the giant star, we can therefore see much deeper—through layers containing far more tons of material per square mile (and, of course, *à fortiori*, to a very much greater depth in miles). Since there are more metallic atoms in the path of an equal beam of escaping light, the lines ought to be stronger. So they are, in the case of the ionized atoms, which are in the majority, even in the sun. But the low pressure in the star leads to the break-up of so large a fraction of the neutral atoms that those which are left are no more numerous than in the sun. This accounts fully for the behavior of both the sets of line described above. But when we come to the white stars, like Sirius, and to the lines of hydrogen which are the strongest of all, we find a contradiction. These lines are strong in the less luminous and smaller stars, and much narrower and weaker in huge super-giant stars like Alpha Cygni. There is no theoretical reason to suppose that at this higher temperature the laws which govern the atmospheric haze are reversed. Indeed, we have evidence that they are not, for the lines of the metals are much stronger in Alpha Cygni than in Sirius—indicating a thicker atmosphere. Granted this, we are faced with the anomaly that a smaller quantity of hydrogen, in the denser star, produces stronger lines than a much larger quantity in the rarefied atmosphere. The solution of the particular puzzle lies in certain peculiar properties of the hydrogen atom and its spectrum.

IF hydrogen is stirred up to shine in a tube within which there prevails a powerful electric field—a gradient of thousands of volts per centimeter—its spectral lines, originally single except when observed with very high power, break up into complete groups of equally spaced lines. The stronger the electric field, the wider is the pattern, and as we pass from the red line $H\alpha$, to the blue $H\beta$, and the violet $H\gamma$ and $H\delta$, the number of components, and the width of the pattern, rapidly increase. This "Stark effect"—named, like many others, from its discoverer—is far greater for hydrogen than for any other element. Helium shows it faintly, and the heavier atoms to but a small extent.

In a star's atmosphere—which must be a good conductor of electricity—there can be no perceptible *general* voltage-gradient. But, since it is full of electrified particles, any given atom

Small Stars

within it will be exposed to the electrostatic attractions (another name for electric fields) of the neighboring charges. These will never exactly balance one another, and will sometimes be very much unbalanced, when one charged particle is much nearer than the other. Calculation shows that the average electric field acting on an atom will be powerful enough to split up the hydrogen lines widely. If this effect was the same for all the atoms, we would see these lines split up into complex groups: but as it varies very greatly from one to another, patterns of quite different scales will be superposed, and the net effect will be to smear the hydrogen lines out into wide, structureless affairs fading out gradually from center to edge, but with no definite boundary.

It has long been believed, with good reason, that this actually happens. Now the matter has been put to the test of precise calculation by Professor Pannekoek—one of the most distinguished astronomers of the Netherlands—and his associate at Amsterdam, De Verwey.

The calculations must have been very laborious. Starting with a formula showing what proportion of the atoms in a gas of given density would be exposed to electric fields of a certain magnitude, they computed the smearing effect upon the various hydrogen lines. Next, assuming an actual atmosphere composed mainly of hydrogen, they determined the haziness at different depths, and worked out the combined effect of the absorption by layers at all levels, thus finding at last what the stellar line should look like. Separate computations had to be made for each of the four principal hydrogen lines, for different values of the star's temperature, and for several values of the surface gravity. The results justified the heavy work: they brought a complete explanation of things that had previously been puzzling.

For example, it is known from atomic theory that the number of hydrogen atoms which are at work absorbing the red line is much greater than for the blue, while for the violet lines it is smaller still. We might therefore expect that the red line would be the strongest and widest, and the others steadily weaker. But the Stark effect widening is much greater for the blue and violet lines, and the net result turns out to be that these two influences balance one another almost completely, so that all four lines should be of almost equal width—which measures of the spectra show that they actually are.

At very high temperatures, when almost all the hydrogen is ionized, all four lines are weak. Taking everything into account (including the influence of the metallic atoms which are present) Pannekoek finds that, for such a value of gravity as exists in Sirius or Vega, the lines should be widest at a temperature of about 8500 degrees (which is probably not far from that of such stars). His curves, showing the theoretical width of the lines and the way in which the intensity should change from the center toward the edge, agree with actual measures of the lines in Sirius and Vega with remarkable clearness. Now the calculations were made on a basis of pure atomic theory, making not the slightest use of any observed property of the stars (except that their atmospheres were composed mainly of hydrogen). The agreement with observation is therefore an example of the second and higher degree of success in the interpretation of nature. The theory predicts precisely what the hydrogen lines in Sirius are like—and could have been worked out in the laboratory by men who had never seen a star.

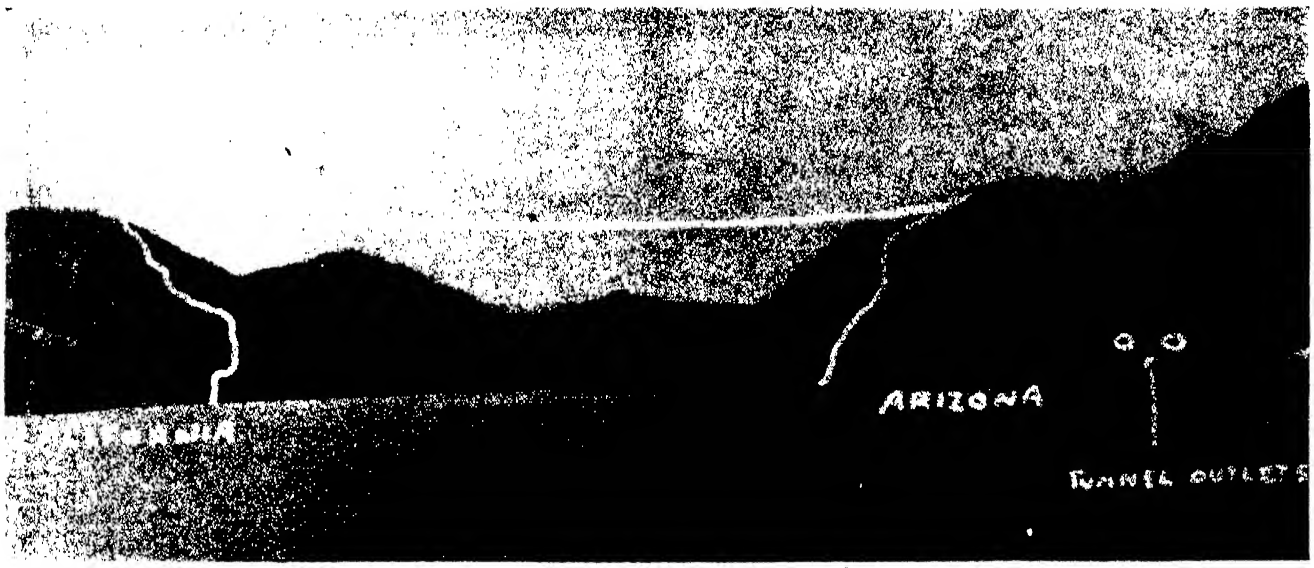
An equally satisfactory result is the full explanation of the abnormal behavior of the hydrogen lines in stars of different brightness. If the force of gravity is a hundredfold greater on one star than on another of the same temperature, the new formulas show that the atmosphere of the first star will be so much hazier that the actual quantity of gas (per square mile) above the level to which we can see will be only one tenth as great as in the second. But the greater Stark effect in the first star will broaden the lines so much that they will be two and one half times as wide as in the other.

By far the greatest known force of gravity is found at the surfaces of the white dwarf stars. On the companion of Sirius it is about a thousand times as great as on the sun or on Sirius. We might therefore expect that the hydrogen lines would be correspondingly widened—and so indeed they are. At the same time, the atmospheres of the white dwarfs should be thin, containing much less material per square mile, and this accords with the fact that the lines of the metals—such as the great magnesium line at 4481—are hardly to be seen at all in their spectra.

Pannekoek concludes that, when the width of these lines has been accurately measured, we may be able to calculate from this alone the force of gravity at the surface of a white dwarf, and so to get an independent estimate of its mass, even if it is not double.

Only those who have engaged in similar calculations can realize how much work lies behind the pages which tell this new story, but the remarkable success which has repaid it may, it is hoped, be intelligible to a larger circle of readers.—*Princeton University Observatory, October 3, 1935.*

At the left is the 61-foot dome which houses the new 74-inch reflector (see page 292) at the observatory of the University of Toronto, 15 miles north of the city. At the right is the new administration building with three smaller domes on top. Of these the nearest houses a 19-inch reflector built at the University by Prof. R. K. Young, assistant to the Director, Prof. C. A. Chant. Prof. Young is not only an astronomer but a telescope maker and mirror maker in his own right. The two other domes are later to house other telescopes. The big telescope is to be used mainly for spectrographic purposes, including radial velocities and physical constitution of stars fainter than sixth magnitude. It will be reserved for public use on Saturday nights. The observatory buildings will be open for inspection on certain afternoons. The administration building is made of white stone and contains offices, a library, a machine shop, several laboratories, and a lecture room



Illustrations courtesy Metropolitan Water District

A view of the valley of the Colorado River, showing the location of Parker Dam and the diversion tunnels

COLORADO RIVER'S NEWEST DAM

Will Divert Water for California . . . Gates to Control Severest Floods . . . Concrete Arch Type

By ANDREW R. BOONE

PARKER Diversion Dam, now under construction on the Colorado River 150 miles downstream from Boulder Dam, will perform the very useful function of storing water in a reservoir 100 miles long from which the Metropolitan Water District will draw ultimately a billion gallons of water daily for use in Southern California. [See September and November, 1934, Scientific American for details of the Colorado River Aqueduct.—*Ed.*]

The diversion dam will raise the water about 72 feet from present river level to an elevation of 450 feet above sea-level, thus providing a 717,000 acre-foot storage basin for regulating and clarifying the water. The dam will be of the concrete arch type and will contain a total of 7,479,000 cubic feet of concrete in the dam proper, the spillways and piers, and so on. Five 50-foot by 50-foot roller-bearing gates on the crest will provide for the passage of floods.

The large gates can be lifted bodily to relieve the pressure built up by a possible flood sending down the canyon the staggering total of 500,000 second-feet, or 326 billion gallons of water every second. This figure tops the biggest flood recorded on the Colorado in 50 years, and includes both the maximum capacity of Boulder Dam's spillways (400,000 second-feet) and 100,000 second-feet of inflow along the river below Boulder. Thus there will be no danger of flooding the Mojave Valley, including the city of Needles, 100 miles upstream. These five gates will occupy openings within the concrete superstructure. Normally, all gates will occupy the closed position, during which time water will pour down through the power plant, which, when built, will develop 80,000 horsepower.

Parker Dam will cost 8,000,000 dollars—only one sixth the cost of Boulder Dam. Pumping station and power line will bring the total construction charges to 28,000,000 dollars. This figure would have been much higher were not construction proceeding at a time when the Boulder Dam reservoir is filling, thus diminishing materially the need for more and larger diversion tunnels at Parker.

Designed and constructed by the United States Government through the agency of the Bureau of Reclamation, with funds furnished by the Metropolitan Water District, the dam and reservoir will be owned by the Government and will be operated by it. The United States retains one half the power privilege at the dam and a limited right to regulate the top 10 feet of storage in the reservoir. The remaining half of the power privilege belongs to the District. A contract for construction of the dam has been let by the Bureau of Reclamation to the Six Companies, Inc., and construction activities have been started.

The actual diversion of water to the aqueduct is to be made by two pumping plants, the first with a lift of 290 feet, and the second of 302 feet.

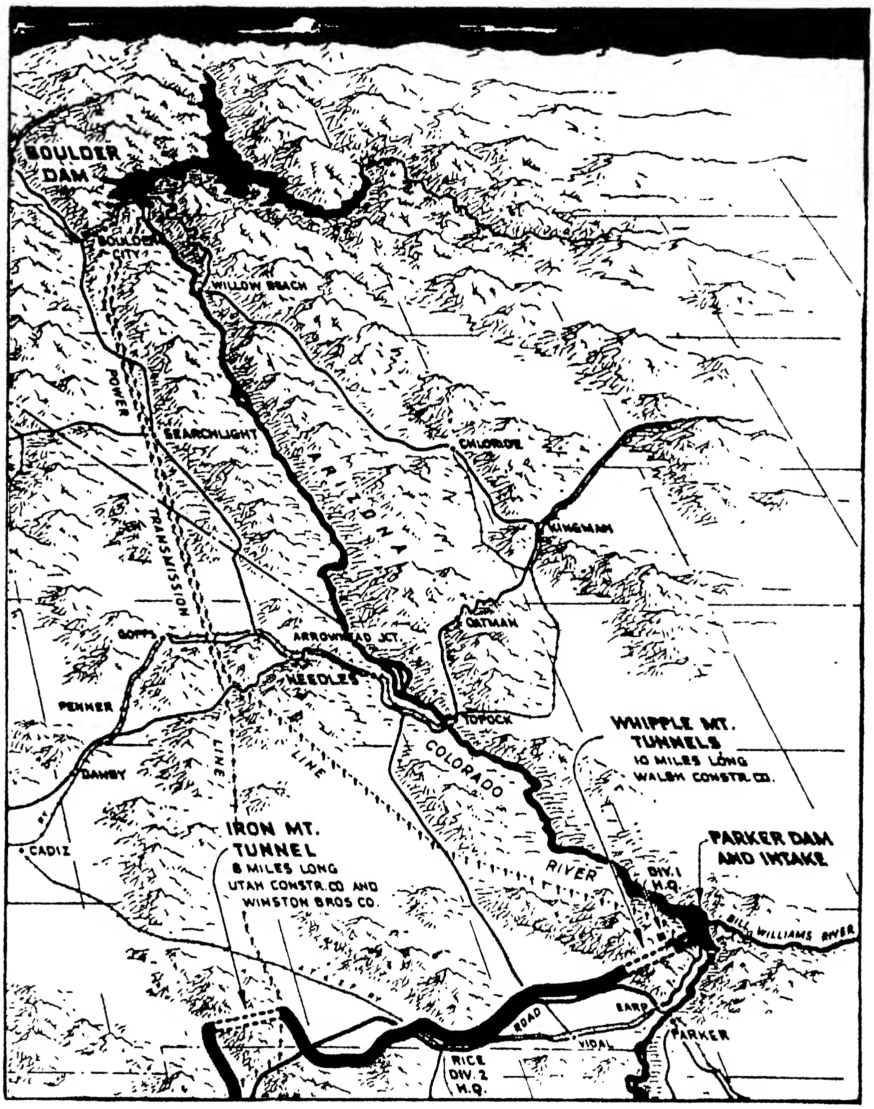
Although nine pumps—eight operating, one standby—eventually will lift a billion gallons daily 1700 feet in five stages from the river through the aqueduct over the mountains, only three will be installed initially. The pumping


Ends of the two 29-foot horse-shoe type diversion tunnels built at Parker Dam

problems are being studied now by the engineering department at the California Institute of Technology. "When all pumps are in operation and delivering the full 1600 cubic feet per second," explained Prof. R. L. Daugherty, "there will be required about 350,000 horsepower for the entire system. The power required for a single pump will range from 4000 horsepower in the lowest head plant (160 feet) to 12,000 horsepower for the highest head (480 feet)."

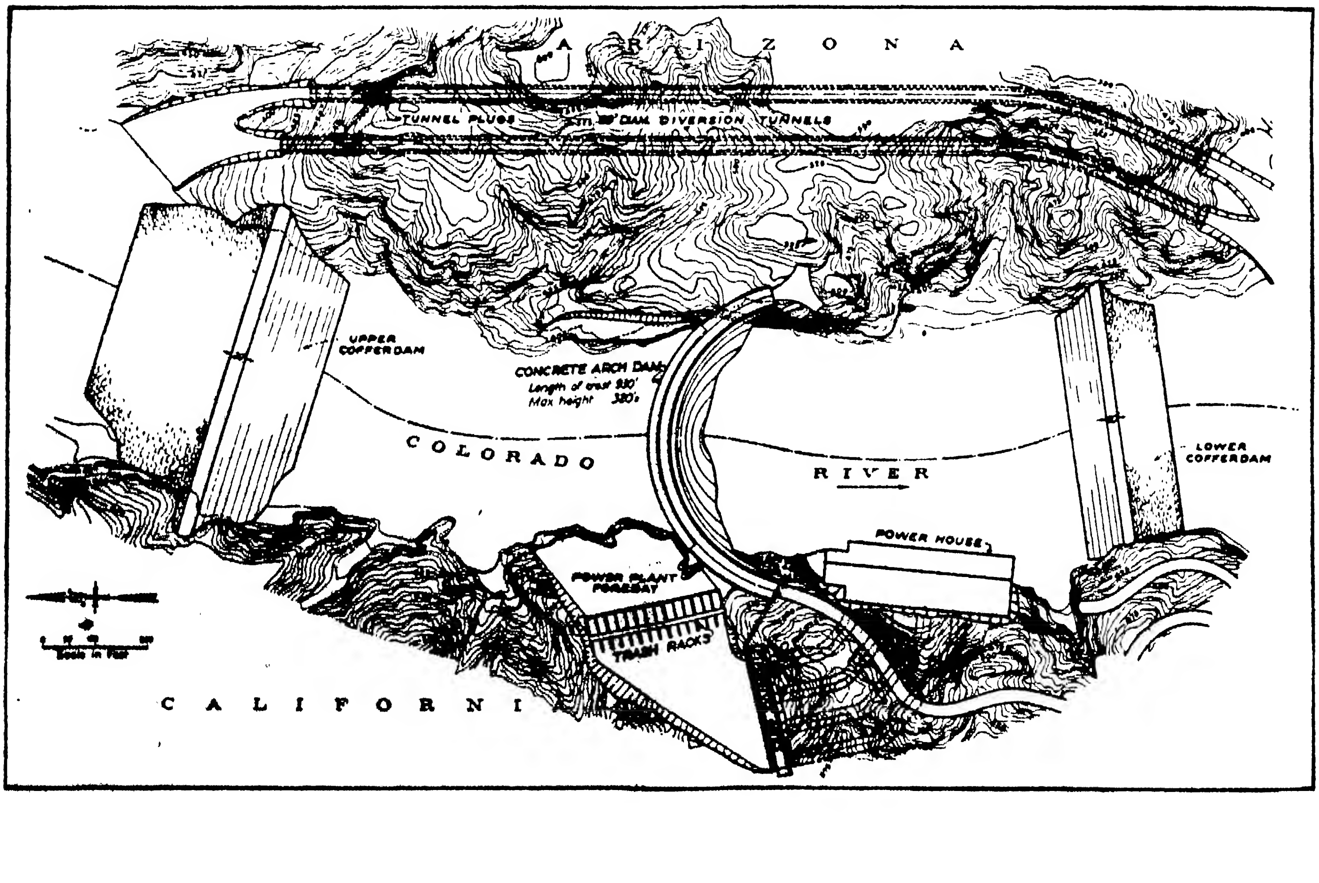
During early years of operation energy for lifting some 300,000,000 gallons daily will be supplied by power from Boulder Dam. The aqueduct is being financed with proceeds from 50-year bonds, and its full capacity of one billion gallons daily will be reached sometime before the half-century period has run. It is anticipated the dam will be completed sometime in 1938, coincident with completion of 13-mile San Jacinto tunnel, final unit of the aqueduct.

Careful study of all possible routes led to the final selection of the diversion site, 16 miles up the river from Parker, Arizona. This selection was influenced by a combination of economic, topographic, and geologic factors. It is considered the safest route to build and to maintain; it requires less gross pump lift than any other feasible route; the river is confined at the point of diversion in a narrow rock canyon.



Right: **Map showing the location of Parker Dam and near-by projects**

Below: **Plan of Parker Dam, giving pertinent dimensions and other data**



PREHISTORIC BURIALS OF TEPE GAWRA

By CHARLES BACHE
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THE tombs under discussion in this article were found intrusive in Levels 9, 10 and 11 of the great city mound at Tepe Gawra, described in an article in the October number of Scientific American. The contents of the tombs indicated a culture quite unlike the culture of the occupational levels immediately below or above the levels of the tombs. Objects found in the tombs, with the exception of a very common type of bead, are never duplicated by objects found outside, but within the same strata. One would naturally expect the dead to be equipped with the best of their possessions, but even in the rare instances where we found ordinary every-day objects, such as pottery vessels, they were also dissimilar from objects used by those who *lived* on Gawra.

Despite the fact that there is no difference in the culture of Levels 8 and 9, we are forced to the conclusion that at the end of the occupation of 9 and before the beginning of 8 there was a break in the continuity of the occupation of Tepe Gawra. For some reason—invasion, disease, fire; exactly what we cannot tell—the Gawrans deserted their mound, and some other people who may have lived nearby used Tepe Gawra as a necropolis. Not only did they bury their dead on Gawra, but they even robbed the ruined temple of Level 9 of its sun-dried brick for the construction of their tomb walls.

Today there is nothing that indicates where the village or town of these people was. Perhaps they lived close to Jebel Badhiqa, where there was an excellent water-supply, about a mile from Tepe Gawra. Perhaps they built their houses at the base of Gawra. Wherever their abode was, we have yet to find it. That it was not on Gawra, we may be sure.

In all, 23 *libn*[1] tomb burials were excavated in the last two campaigns: 14 in the campaign of 1932-33, 9 in 1934-35. Exactly one half of those found in the earlier campaign had been robbed. None of the more recently discovered burials, all in Levels 10 and 11, was disturbed before we came upon them. For this reason we were able to obtain structural details which had been lacking until the last few months. It can be stated with almost certainty that the same method of construction was followed in every one of the tombs, with a single exception.

THE general method is as follows (See Figure 1): a hole, generally about four feet deep, eight feet long and five feet wide, was dug in the debris of the *tell* (hill). All sides of this pit were lined to the top with walls of *libn*. The size of each *libn* is approximately 3 by 8 by 16 inches. Usually the walls of the tombs are but one *libn* in thickness, although occasionally we have found tombs where all walls are of double thickness, and we have one or two instances in which the long walls are double, the end walls single.

Beyond leveling it off, there was no especial preparation of the floor of the tomb. Over it, the construction of the walls being finished, there was placed a reed mat on which the body of the lamented one was placed. The body was always in a contracted position—knees drawn up so that the thighs were at right angles to the trunk, legs placed as close to the thighs as possible, so that the angle of the knees was very acute, the body lying on its side (there was no rule for which side) the elbows at the chest, the hands raised to the mouth. In the hands were then placed the funerary objects. In one tomb only did we find a deviation from this rule.

Then the body was covered with another reed-mat, or the mat that already was beneath it was wrapped around the body. Over the body was then built a small wooden structure (See Figure 2). That it had a gabled roof, we know. We have found traces of the ridge poles in several of the tombs, as well as the remains of the corner posts, their tops somewhat lower than the ridge poles. While we have found the remains of the boards that formed the roof, we have no evidence for assuming that the structure had board walls as well. It is possible that it did. The roof of this added protection was somewhat lower than the tops of the walls of

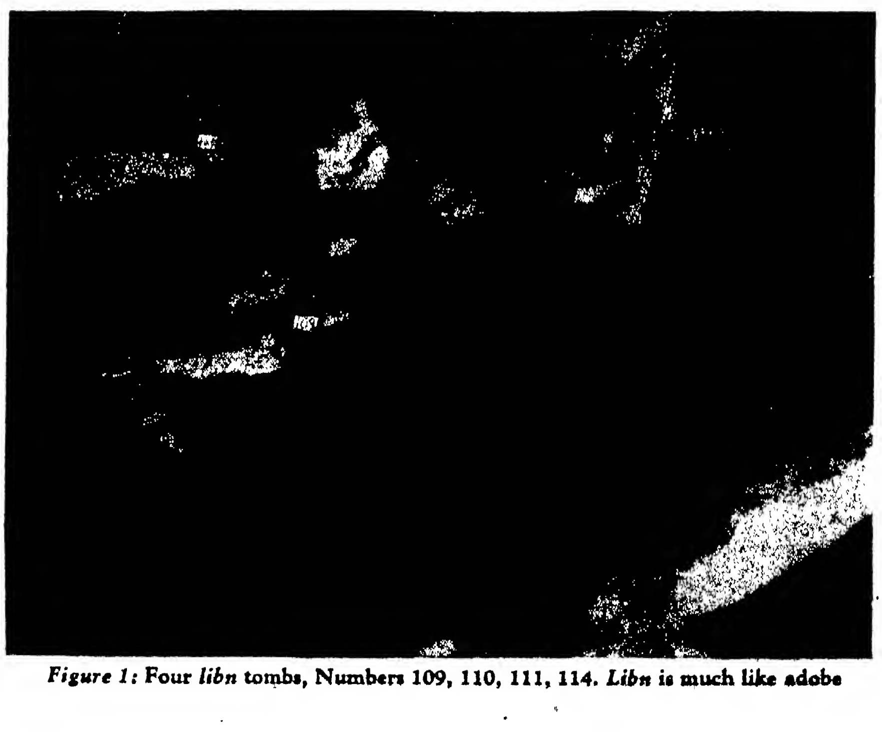


***Figure 1:* Four *libn* tombs, Numbers 109, 110, 111, 114. *Libn* is much like adobe**

[1]A sun-dried mud brick, similar to adobe.

libn. Therefore, the intervening space was filled with dirt to the upper level of the walls. Covering the whole structure and extending to the outside of the walls was placed another reed mat, held in place by two additional courses of *libn*, placed on top of the walls. This mat was then well plastered over with mud, and the burial was finished.

In almost every excavated tomb, objects and skeletons were in badly damaged condition. Very frequently substantial things, such as stone vessels, were shattered. Until recently we suspected that these had been intentionally "killed," but we now know that our assumption was incorrect. It is almost certain that in the course of the years after the burials the posts that supported the wooden roofs rotted away, allowing the tons of accumulated earth above to fall in the tombs, crushing the skeleton from which the flesh had already decayed, smashing any brittle object that offered resistance, and bending and twisting gold ornaments that formed decorations on the bodies.

While there was no definite practice in the orientation of the bodies themselves, very definite rules for the orientation of the tombs obtained. Their corners were *always* at the cardinal points of the compass, the longitudinal axis northwest-southeast. No exception to this rule was found. In connection with this, it is interesting that in all buildings of Levels 9, 10, 11, and 12 the same rule also held true. Corners of rooms, and corners of the buildings, were at the same cardinal points. In the case of buildings, however, the longitudinal axes are northeast-southwest.

Twenty-three Tomb Burials Excavated . . . Apex of Stone Craftsmanship and Goldsmith's Art . . . Over 5000 Years Old . . . Who Were the Gawrans?

As stated above, 23 tombs were excavated, of which a number merit description here. The others had been robbed, or else had originally contained no objects.

In Tomb No. 24, the skeleton lay on the left side, its skull at the southeast end of the tomb. Held in the hands, which were raised to the face, or near the skull, were two interesting objects: a comb and the hair ornament shown in Figure 3. Both are of bone. The hair ornament is a striking work of art, with four bands of gold around it, both for decoration and reinforcement of the fragile bone needle. The central portion is inlaid with lozenges of turquoise and lapis-lazuli, in alternate spiral rows. It must have been worn so that the points were thrust in the hair, leaving the colorful center exposed. I believe I am safe in saying that this piece is quite without parallel.

Tomb No. 25 contained a double burial. It was built in connection with No. 24. Skeletons lay on their sides in the usual sharply contracted position, facing each other, their knees touching, their heads at the northeast side of the grave. The tomb contained no funerary objects beyond a stone amulet and a gold earpendant. This instance of double interment will be discussed below under No. 111.

Tomb No. 30, which measures about 82 by 60 inches, is also a double burial,

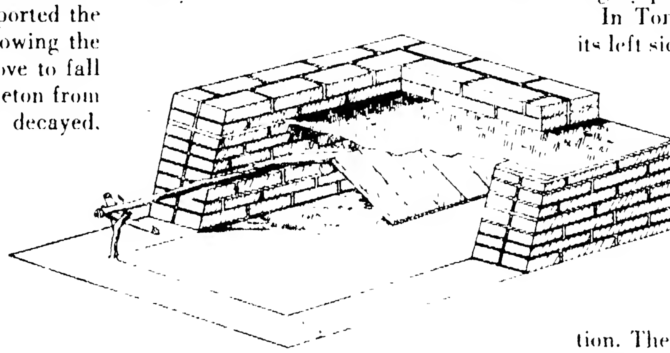


Figure 2: **Reconstruction of a *libn* tomb, showing walls, mat, and roof**

but in character dissimilar from No. 25. One skeleton lay on its left side, head at the northeast end of the grave. The other—smaller—lay at the feet of the larger, its head almost in the south corner of the tomb, the body parallel to the southeast wall, on its right side. It will be of interest for the reader to contrast this burial with Nos. 25 and 111. No objects were found in the tomb.

Tomb No. 31 is one of the richest burials we have found in Gawra. All objects were found close to the face, as if they had been placed in the hands of the corpse at time of burial. Besides a string of 512 beads of shell, carnelian, lapis-lazuli, turquoise, crystal, and gold, there were four stone vessels, two stone objects of uncertain function or purpose (Figure 4), a seal-plaque, two combs, and a hair-ornament, all of bone. Gold in the form of hemispherical studs and a rosette with a gold dangling ribbon was also found. The studs had been filled with bitumen and affixed with this adhesive to cloth, the imprint of which still remained. Very likely these latter formed a fillet that was worn around the head.

A seal-plaque found in the same tomb shows a man driving before him an ox or bull, and over the bull is the "star" sign, later to become the "ilu"—symbol of divinity, probably Enkidu. Incidentally, this is the first indication of any attempt at writing that has ever been found on Gawra—even in the later levels in which times writing is known to have existed.

Four vessels also were found. A tiny alabaster jar, not two inches high; an unusual object consisting of two bowls carved out of one piece of "Mosul" marble; a small incomplete bowl, 1½" in diameter of oölitic limestone and lastly a beautiful handled bowl of steatite (Figure 5). The last is translucent and highly polished.

In Tomb No. 34 the skeleton lay on its left side, its head at the southeast end of the tomb. This is the largest tomb of Gawra, and is also one of the poorest. I believe, however, that it had been robbed in ancient times, as the skeleton was not complete—all of the body above the pelvis was missing, only the skull remaining of the upper portion. The only object was a large comb (Figure 6) of the "Spanish" type—curved to fit the back of the head. Most of its teeth were gone.

No. 102: While this is not intrinsically the richest tomb, archeologically its contents are the most important that we have. In their order of importance, they are: a pottery dish of coarse redware; a pear-shaped mace-head of oölitic limestone; 28 stones, a few unshaped, a few roughly cubical, the majority spheres, all intended as ballistas; 260 large beads of white shell and carnelian, worn as a necklace; over 25,000 small beads, all discoid, of which all but 1100 were white shell. The 1100 were made of obsidian and, on account of their size and number, are quite unusual. Judging from their position in the tomb, they formed, it is likely, a bead jacket. Strung together, the strand is over 145 feet in length.

The two most distinguished objects may be seen in Figure 7. Made of obsidian, these spouted vessels represent the apex of stone craftsmanship. Anyone who has ever attempted to work flint or obsidian can appreciate the skill and labor that was put into the manufacture of these finds. In the Iraq Museum in Baghdad the visitor may see a silver ewer recently discovered at Warka (Erech) in southern Babylonia. If one were to place this ewer beside the obsidian ewer at the right in the illustration, it would be almost impossible to distinguish them, if material be disregarded, so alike are they in size and shape. It is a parallel such as this that makes a find of importance. A unique

object may be of interest, but in archeology the old adage that "comparisons are odious" collapses loudly.

No. 107: Skeleton on the left side, its skull at the center of the southeast wall. The only objects were a half-dozen ballistas of alabaster.

No. 109: For the purpose of museum display, and in actual *intrinsic* value, this is the richest tomb on Gawra to date. Here I will not attempt to describe all the gold objects—some may be seen in Figure 9. A total of 410 was found —falling into 12 separate categories: 235 beads of gold and electrum; 90 "bangles" shaped very much like a tennis-racquet (apparently these bangles were part of a necklace which was also comprised of pearls); eye-shaped ornaments, use or purpose unknown; flat crescents, pierced at each end for stringing; a ferrule (for a sceptre?); six clam-shell-shaped ornaments; 50 hemispherical studs, similar to those of tomb No. 31 and rosettes, both plain and with dangling ribbon.

QUANTITIES of beads were also found—lapis-lazuli, turquoise, carnelian, and white limestone. The majority were of lapis-lazuli, and some of these were carved in unusual shapes. An amusing and interesting object is a representation of a flying-ant; its globular body is lapis-lazuli, its wing and head in electrum. Two splendid obsidian razors and a bone comb were found underneath the hands. The comb was 8¼ inches long, with a very massive grip. It could not have been worn, as it was straight, and must have been used in caring for the hair.

The small black and white marble jar shown in Figure 8 is one of the daintiest of stone vessels that has come from Gawra burials. It is absolutely undamaged and is perfectly executed throughout. Two other bowls of stone, one of alabaster and one of oölitic limestone, complete the list of furnishings for this tomb. These last two are the exceptions to the rule that all objects are placed at the head of the skeleton in its hands—both were found, inverted, at the feet. The oölite bowl (Figure 11) is an excellent piece, with a decorative notched molding near the outer rim, on the almost flat shoulder. It, too, is undamaged. The alabaster bowl mentioned a few lines above is dull and uninteresting. Hemispherical, it bears no ornamentation, and the soft alabaster was badly crumbled on the bottom and around the rim.

No. 111 contained three skeletons. It was built in direct association with No. 109, the northwest wall of the latter being the southeast wall of the former. This same condition obtained in Nos. 24 and 25. Except for No. 25 being double, and 111 being triple burials, they are strikingly similar. Each joins

Figure 3: **The hair ornament found in Tomb No. 24. It is made of bone, with four gold bands around it, and inlaid with both turquoise and lapis-lazuli**

Figure 4: **Two stone objects of uncertain purpose, found in Tomb No. 31**

Figure 5: **A beautiful, handled bowl of steatite,—translucent. From Tomb 31**

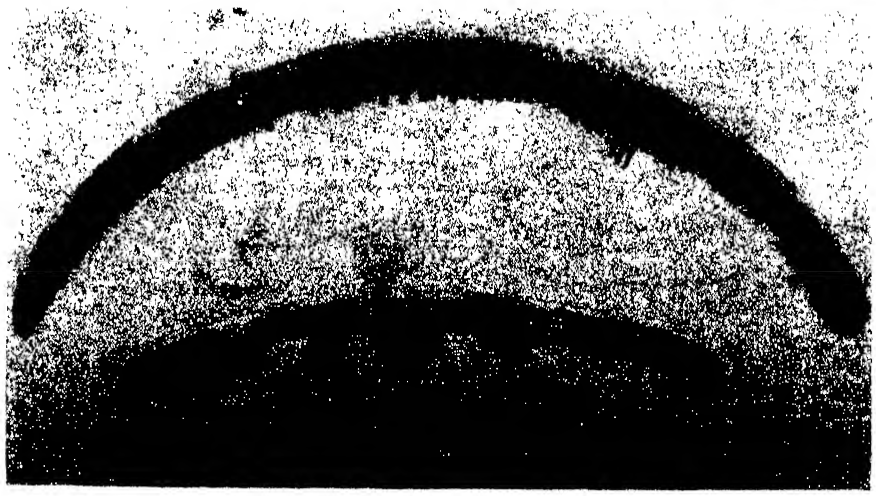


Figure 6: **A large comb antedating the Spanish type; also a straight comb**

a rich single burial. Each in itself was woefully poor in tomb furniture. Each is northwest of its rich companion tomb. In all probability each of them was built at the same time that the richer burial was made. In each case, the multiple burial lay at the *feet* of the skeleton in the richer tomb.

Of the three skeletons in No. 111, only one had with it anything in the sense of ornament—an inconspicuous string of 71 beads and pendants, seven of which were of gold, the rest of the usual semi-precious stones—lapis-lazuli, carnelian, and so on. Each skeleton was provided with a plain earthenware pot. Contrast this with the marvelous stone vessels in No. 109, 102 and 110. In view of these circumstances, is it unreasonable to assume that here we have examples of human sacrifice to a dead chieftain? In a somewhat later period at Ur, in the Royal Cemetery, there are examples of this same sacrifice on a much larger and more impressive scale.[2] It seems to me that more than likely either slaves, followers, wives, or concubines of nobles were slain and buried with them to minister to them in after life, as they had done in this world.

No. 110: The tomb was quite a rich one but it presents no feature of extraordinary interest. It contained the usual type of gold ornaments—rosettes and eye-shaped. For the first time we found the extruding nipple of stone in the center of the larger rosettes (Figure 9). One was of lapis-lazuli, the other of a green stone which we have not yet had identified. Also of interest is that here we found the original order of stringing beads of carnelian and gold: that is, the ten carnelian discoids, one gold cylinder and so forth. Two rotting maceheads of limestone, and six ballistas of alabaster were also found. A curved bone comb and a seal stamp of lapis-lazuli almost complete the roster of objects.

The two finest things are the steatite cups shown on either end of Figure 8. Absolutely symmetrical, elliptical in plan at their rims, of extreme thinnesses as to ware, their very shape precludes the use of the wheel, which at this time was not in use on Gawra. While steatite is an infinitely more tractable material in the hands of an artisan than is obsidian, these cups, by their shape and

[2]C. L. Wooley, "Ur Excavations, II," The Royal Cemetery, p. 73.

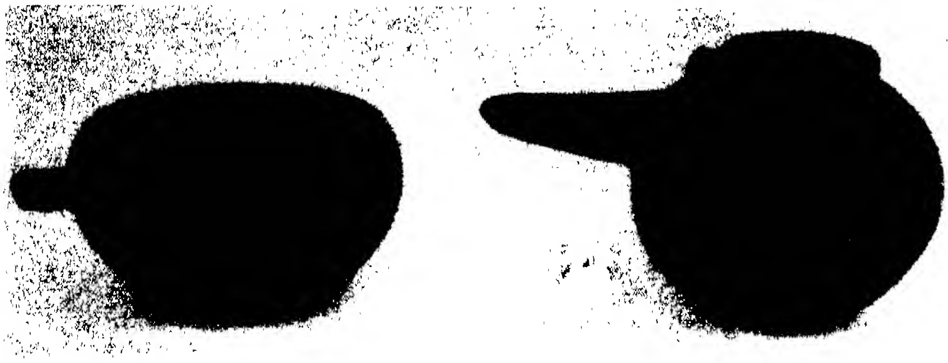


Figure 7: **Spouted vessels representing the very height of craftsmanship. They were made of obsidian, a very hard stone**

Figure 8: Center: **Black and white marble jar. Cups from Tomb No. 110**

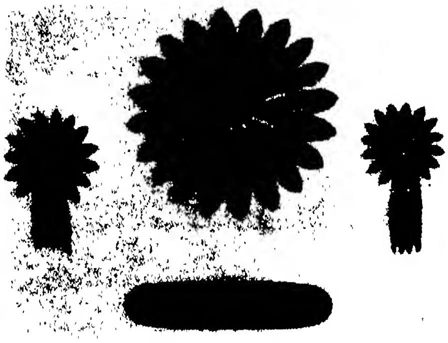


Figure 9: **Gold ornaments from various tombs, as well as the hone from No. 114**

Figure 10: **Gold-silver alloy wolf's head, Tomb 114—"most beautiful"**

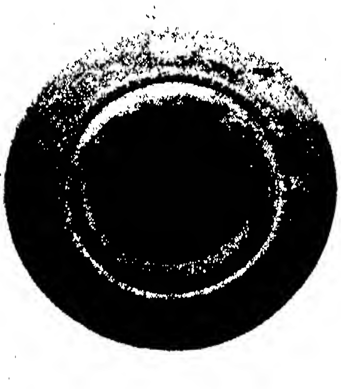


Figure 11: **The oolitic limestone bowl from Tomb 109—undamaged**

workmanship, are impressive monuments to the exceptional stone work of the Gawrans.

No. 114: If No. 102 is archeologically the most important tomb, then, esthetically, 114 is the most important. Had we excavated but these two burials and found nothing else, we could still count our results as being more than worth the expenditure of effort and money in obtaining them. In Tomb 114, the skeleton lay on the left side, the skull to the southeast end of the tomb.

The wolf-head shown in Figure 10 is unquestionably the most beautiful object that has come from Gawra's tombs. So realistic as to be almost breath-taking, it is the zenith of the goldsmith's art in these early times, and will compare more than favorably with the finest metal work of any time. It is made of electrum, a natural alloy of varying proportions of gold and silver, much in use among the ancients, and is beaten around a core of bitumen (asphalt). The lower part of the mouth is removable, being attached to the main part of the head by means of a prong that penetrates to the outside of the under-jaw, and is bent upward to hold it in position. The ears, which had fallen off, are attached by means of copper pins, their only trace being the dust of the green oxide. Doubtless the eyes, which are missing, were of glowing carnelian, or some colorful stone. The teeth are also made of electrum, drawn into wire, the points sharpened to needle-sharpness. Probably this head was fixed to the end of a wand—perhaps as a symbol of authority wielded by some high official of the ancient city mound of Tepe Gawra.

Another fine object, beautiful for its very simplicity, is the hone shown at the bottom of Figure 9. It is made of hard, green stone with a plain band of gold about its middle. An unusual pear-shaped mace-head of hematite, with three projecting knobs on the heavier end, and three simple bone hair ornaments with gold bands, finish the list of unique objects from this fascinating burial. Besides these things, there were many other objects which add to the wealth of the tomb. A seal stamp of lapis-lazuli, depicting a leaping gazelle; a gold rosette, large and with a nipple of stone; many hundreds of beads — gold, carnelian, and so on; six ballistas made of a marbled red stone, and an alabaster mace-head, bring the list of objects to an end.

This was the last tomb of importance that was excavated in these two seasons. At the beginning of this article, I mentioned the fact that there was but a single exception to the rule in the construction of the tombs. This was one that contained no objects, but is of interest since, inside the *libn* walls, it was lined with large stone slabs, with a slab floor and a slab cover.

To set an exact date for these burials is difficult. It is doubtful that it will ever be done with certainty, since there are no historical data nor written evidence for it. At this time, a conservative estimate will suggest that 3500 B.C. is a reasonable date. They cannot be more than a few years later than this, and it is very possible that they are considerably earlier. The levels in which they are found are 20 feet below the level contemporary with the First Dynasty of Ur—beginning 3100 B.C. Between this level (6) and the tombs, there was a long occupation, marked by constant building and re-building in all the phases of stratum 8, and at the conclusion of 8 there was yet another long period before the building of 6 started. The date 3500 B.C., while only a hazard, is certainly not a reckless one.

It is interesting to note that the walls of Level 8 were built over some of the tombs discussed in this article and that in some few instances the builders of Level 8 must have broken into and robbed them. We found, in tearing down this stratum, a fragment of a stone vessel, the rest of which was later discovered on the floor of one of the pilfered tombs.

In the 9th and 10th levels, tombs were confined to the north and west sections of the *tell*. Since only the north and east sections of Level 11 have so far been excavated, we cannot yet say definitely whether or not their location is similarly restricted in this level. However, none was found in the excavated east section of Level 11—only in the north. All the tombs of Level 11, being buried in débris far deeper than those that were found in Levels 9 and 10, were unrobbed by the builders of stratum 8.

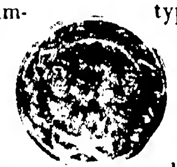
...Not Just Glass

Glass Age is 6000 Years . . . Last 20 Have Seen Most Progress . . . Important New Uses . . . Architectural, Industrial, Scientific Types of Glass

By PHILIP H. SMITH

YOU can now build a house of glass and live comfortably—and privately—within it. What is more, you can throw all the stones you wish with impunity, for glass research has outmoded the old adage.

If you think of glass only as a brittle, transparent material which must be protected from shock, then you are sadly uninformed. This clear, fragile material has been worked over until established definitions for it are inadequate. The commonplace glass which you purchase for window panes must still be protected from baseballs, but there are types which will withstand terrific impact. And there are types which transmit the infra-red rays, or ultra-violet rays; X-ray protective glass which is equal in effectiveness to one third its thickness of lead; and bullet-proof glass made of laminations of plate glass and plastic. Glass is no longer just glass.



Students of glass history give it an age of 6000 years, but aside from advances in the technique of making art objects, very little progress was made for a long span of years. More progress has been made within the past 20 years to determine just what glass is, what can be done with it and how to do it, than was accomplished in all the previous 5980 years. That is why when you examine glass manufacture today, you find a backward industry moving forward at astonishing speed.

RESEARCH has made possible the enormous strides, and research is guiding the industry today. Manufacturers will admit this even in plants where research facilities are slim. And with all that has been accomplished we are admittedly only on the threshold of developments. It has taken years to attain a scientific understanding of the commonplace practices of centuries and this had to be acquired before departures could be made. Now, with better foundations laid, developments should come thick and fast; indeed, they are already crowding upon the stage.

Let us look at glass as a building material. In this form it touches the greatest number of people. By the time this article reaches your hand you will be able to order a house built of glass and get prompt delivery, and you can be assured that nothing of privacy will be lost. There will be no particular problem in heating it or keeping it in repair. Glass building blocks have made this possible.

There are going to be several types of glass building blocks available, variously called structural units, bricks, masonry, or tile, but a description of one type will come very close to describing them all as regards fundamentals of design. The unit is made by taking two box-shaped pieces, or a box and a lid, and fusing them together on their edges to form a hollow block. There are various sizes and several methods devised for cementing the blocks into place in a wall. The inside faces of the block are fluted in such a manner as to break the light rays and destroy all images—hence your privacy.

The hollow, fused construction has very distinct advantages. With the cooling of the block, following the heat of fusing, a partial vacuum is created. This insures that there will be no frosting of the glass due to moisture within the void. By using a glass having a very low coefficient of expansion, wide variations in temperature can be withstood and a large number of units can be assembled to form a wall surface with safety.

One might question why such blocks have not been available in the past, since the glass house isn't a brand new idea. There have been houses erected with glass walls all over the world, particularly public buildings, and they have withstood the ravages of the elements. Perhaps the best explanation for delayed use lies in architectural style. Glass walls envisage "modern" architecture and the public was not ready for it. Before there could be this radical departure in materials there had to be a like departure in public taste.

Can you now vision this glass house? It will have perfectly smooth interior and exterior walls which can be easily washed. The fluted interior of the blocks will give a diffused light throughout the

Are we to have a "glass masonry" age? Some people predict it. Here we see how easily a glass brick in a house wall may be replaced. Note the prismatic surface

house, no matter how strong the sunlight. And in cost it will be comparable to brick.

While glass building blocks are a distinct departure, their development followed quite naturally upon the advances which have been made in architectural glass. Manufacturers have learned how to make special glasses to render particular services and they have established a control in manufacture which assures getting the uniform result they want.

WITHIN recent years, given the new types of glass, the idea has grown among architects and builders that here was a material which not only transmitted light rays, but could be made to contribute a superior decorative effect if given the proper treatment. In the effort to accomplish this, many other fields were drawn upon to yield their best of recent advances. For example, illuminating technique was brought to bear on the problem of handling light within buildings and we have what is commonly termed "indirect lighting." Instead of a concentrated light source for the illumination of a room, which is nothing more nor less than the modern version of the candle, there came diffusion of the rays through the use of fluted glass, so that today an illuminated frieze or pilaster is quite commonly used in large buildings as a light source. Color effects, too, have been obtained by utilizing colored (neon) lights and filters to the end that great panels and columns of color replace orthodox lighting.

The advent of glass having a low coefficient of expansion promptly increased the potentialities of glass as an exterior wall material. Actually this type has less movement under temperature changes than most of the metals and can be used without hazard of breaking. For the sake of appearance, such glass is joined with opaque cement or a synthetic resin. The chemist has made a definite contribution to glass by providing a transparent binder, having a high light transmission factor and a bending quality that surpasses the opaque cements.

Glass is certainly "not just glass" when it is tempered and strong enough to support tons

Among the special glasses contributing to the field of architecture is a type which transmits both visible and ultra-violet rays. A small percentage of the ultra-violet transmission is lost after the glass is first put into use, but from then on the transmission is nearly constant. The principal use of this glass is in sanatoria and hospitals, but now that costs have been lowered it is beginning to replace ordinary window glass in homes. Then there is glass which absorbs a large part of the heat or infra-red rays while transmitting most of the visible rays. This type is eminently suitable where it is desired to keep out the sun's heat, as in air-conditioning where inside control of heat is sought.

More recently, double-glazing has been launched. This development for windows was mentioned in a previous article[1], but some of the technical problems involved are significant of the research conducted to get a satisfactory product.

Like "taffy" on the production line: glass "wool" batts made by patented steam process

Double-glazing is much more than a sash carrying two panes of spaced window glass. Maximum insulation demands a certain dead air area between the panes and the air must be free from moisture, otherwise the glass will "steam" over and vision will be obscured. The seal must be such that no air can enter and yet be flexible enough to permit expansion under temperature changes. Finally, the glass itself should be of a sufficiently stable type so that it will not ultimately develop a cloudy surface.

Light transmission and decorative effects are not the only qualities which recommend glass to the construction industry. Glass can boast insulating properties when made in the form of a wool. The appearance of glass wool is similar to mineral wool. It is simply a batt composed of very fine filaments. Placed in the wall of a house it provides a blanket of stagnant air pockets and it is, of course, very resistant to fire. Glass filaments also serve as filters. For air-conditioning equipment countless numbers of these little strands are laid down in crisscross fashion within a box-like structure. On one side—the outside when installed—the strands are coarse to corral the larger impurities in the air, while on the inside the strands are very fine to remove the smallest particles. Here again resistance to fire is an attribute.

TEMPERED glass, too, will have household uses. Since this remarkable glass was described in these pages,[2] several new uses have been developed. In keeping with the modern trend in interior decoration, this glass has been brought forward as a component material in furniture; and, because it will withstand great heat, it is to be used for firescreens and skylights. In Navy homes—the battleships and cruisers—it serves excellently for portholes. It brings about a great saving in weight because the thickness of the glass can be reduced from $1\frac{1}{2}$ to one half inch with no loss of strength.

Laminated safety glass for windshields has undergone notable improvement under the guidance of research. You may recall the yellowing and fogging of the early types after months

[1]Scientific American, September, 1935, page 137.

[2]Scientific American, September, 1935, page 127.

Amazing versatility: the only gob-fed machine making both small and large bottles—one dram to one gallon capacity

of use. The yellowing was due to the action of ultra-violet rays upon the cellulose nitrate binder of the laminations, while the fogging came from the penetration of moisture between the laminations. Cellulose acetate has replaced the nitrate to provide a much more permanent product and even the glass itself has been improved. For many years safety glass came only in flat form; now it can be had in curved surfaces. It requires more labor to produce the curved type because the two pieces of glass must be heated and bent with very careful indexing so that when they are assembled with the plastic between there will be no distortion of vision.

The answer to the beer can challenge

Quite recently a new type of safety glass was developed which employs another synthetic resin binder. This resin is claimed to have an index of refraction almost identical to glass, hence increasing the transmission of light where it strikes through the inner glass surfaces. The development is significant as indicating the trend of safety glass—better transmission of light and greater clarity of vision. The problem of fogging due to moisture penetration has been solved by proper sealing of all types of safety glass, and the new glass claims to go one step further by using a binder which itself repels moisture.

The advent of glass as an industrial material really dates back to the discovery of boro-silicate, heat-resisting glasses. They were products of research and immediately opened up fields for glass where it had never before been practical. They are highly resistant to heat, have very hard surfaces and great chemical stability. Acids, with the exception of hydrofluoric and glacial phosphoric, show little effect on them and they are unusually stable in the presence of alkalies. Most householders have used boro-silicate glass in the form of cooking utensils, the scientific world has employed it in the laboratory, and industry knows it in the form of insulators or containers for chemicals. Some of the food industries are taking to glass piping because it can be sterilized easily, permits visual inspection, is free from corrosion and resists thermal changes. However, recent advances in the use of glass piping can be attributed not to sudden discovery of these good qualities but rather to better methods of coupling and to lower costs due to machine manufacture.

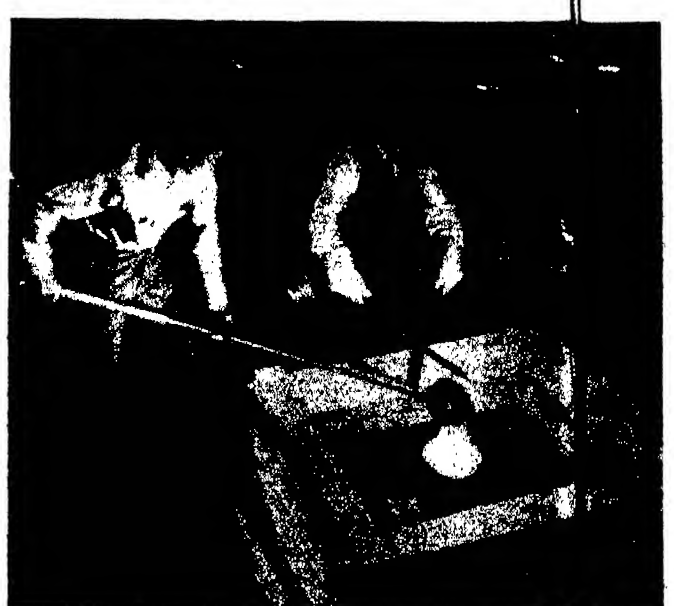
Use of glass tubing in beer manufacture is an innovation; bottling the product in glass is old, so old in fact that it bred the belief that beer would always come in bottles. Imagine the rude shock when the can manufacturers announced that they were going to supply cans for beer. It was a threat of no mean proportion and the glass makers accepted the challenge. The champion evolved for the competitive bout is new in shape. It is lighter in weight, nearly a third lower in height and planned as a one-way bottle. Redesigning permits substantially faster production. So the fight is on.

If it is research which has made possible the recent advances in glass as a material, it is the same persistent study applied to the technique of manufacture which has enabled the many and diverse products to be placed at the service of the consumer, at a cost the consumer can pay. Until quite recently, glass making was a hand craft. Glass blowing was an art; the product almost a luxury. Then, only a quarter of a century ago, innovations began and automatic machinery became a reality. Sheet glass, bottles, bulbs, and tubing underwent a process revolution. Let us see what happened to sheet glass.

Sheet glass was originally made by blowing a cylinder which had to be slit, re-heated and flattened. Today it is drawn in sheets vertically from the molten mass. The early process involved the operations of blowing, cutting, flattening, annealing, and cutting, whereas now it involves only drawing and cutting for the annealing is done in the drawing process. Plate glass, likewise, underwent a drastic change in process. It was cast and rolled on an iron table until technicians found a way of rolling continuously as the glass flowed from a tank furnace. The process of grinding and polishing of the surfaces was an intermittent one until the continuous process was perfected in recent years to raise the production rate from 600 square feet in eight hours to 500 square feet in one hour.

THE first fully automatic bottle making machine was developed about 30 years ago and was responsible for showing that mechanization of the industry was not impossible. Today's bottle making machine is far removed from the first conception. Molten glass exudes from an orifice of the forehearth where it is sheared and dropped, a lump at a time, into a mold for shaping. It is then transferred automatically to the blowing mechanism and as quickly expelled as a finished bottle. Were it not for the advent of this machine which can produce bottles as fast as you can count, bottles could never have been produced at a cost which would permit their becoming a universal container.

Electric light bulbs are also made by machine, the most recent development being a mechanism which can produce over a half million of them in a day, and



A "gather" of glass being poured into a heated mold to form the glass panel which is shown being ground at top of page

Grinding a section of decorative glass panel to insure a close fit when finally installed at Rockefeller Center, New York

that means bulbs for all at a moderate price. The process works automatically, beginning with the flowing of molten glass like a ribbon onto a chain having equally spaced orifices. The molten glass sags through the orifices and immediately another chain overhead causes "blowheads" to register with the orifices, and elongated blanks are blown. At this stage a third chain carrying molds rises underneath, the molds surrounding the blanks, and the blowing is continued until the bulb is formed. As soon as the bulb is shaped, top and bottom chains fall away and the chain bearing the suspended bulbs moves on to where the bulbs are ejected.

The fourth machine in this group which revolutionized the making of glass is one for drawing tubes. The tubing is drawn from a rotating mandrel which is fed with molten glass in a continuous stream and the machine also cuts the tubing into proper lengths. Once made and cut, it is mechanically gaged for diameter, but if a higher degree of accuracy is demanded, an automatic weigher sorts the sticks to closer dimensions. Tubing of small diameter can be produced at the rate of 100 to 150 miles per day.

OCCASIONALLY, one finds that machine operations are combined with a certain amount of skilled hand work. Thermometer tubing is a case in point. The blank is formed by hand and consists of an elongated lump of molten glass backed by a strip of opal glass, carefully formed with a hole in the center. And to provide the necessary magnifying power in the finished tube, one side of the blank is formed V-shape. Following this hand work, which skilfully creates a condensed form of what is wanted, the blank is drawn upward 125 to 150 feet into a tower where, after cooling, it is cut into desired lengths. This, in short, is the machine which has placed accurate thermometers within the buying reach of millions.

The art of glass blowing is not lost and, in fact, still holds its place for certain types of quality products, but it is machine development of recent years which has made glass in its best form an everyday utility. Perhaps the best example of this is to be found in an insulin bottle. Here medical science, glass research, and machine technology have combined to bring relief to mankind. Insulin requires that a glass container be used which is stable in the presence of alkalies, hence a boro-silicate glass is used and small bottles are produced on a machine with an economy that makes them a negligible cost factor in the distribution of this medical aid.

. . . and in industry: glass pipes, couplings, bends, size reductions

Presumably everyone has heard by now of the 200-inch glass reflector cast[a] for celestial observation, and of the plan to use chromium and aluminum to give it its final reflecting surface. Previously mirrors had been coated with silver, and silver was not wholly effective in reflecting the ultra-violet rays; then, too, it tarnished easily and had to be replaced. Small mirrors coated with chromium and aluminum can be used for microscopes, and at a cost of a few dollars they replace very expensive quartz reflectors, while for studying ultra-violet stellar spectra, mirrors with this new surface promise to open wider the secrets of the heavens for scientists.

For thousands of years, glass had a reason for being in that it served man as a light-transmitting material. That was enough to warrant the creation of a large productive industry. But that quality of light transmission is not the one that is sending it forward today. There are other qualities that are recommending glass and new qualities will undoubtedly be imparted to it through the agency of research.

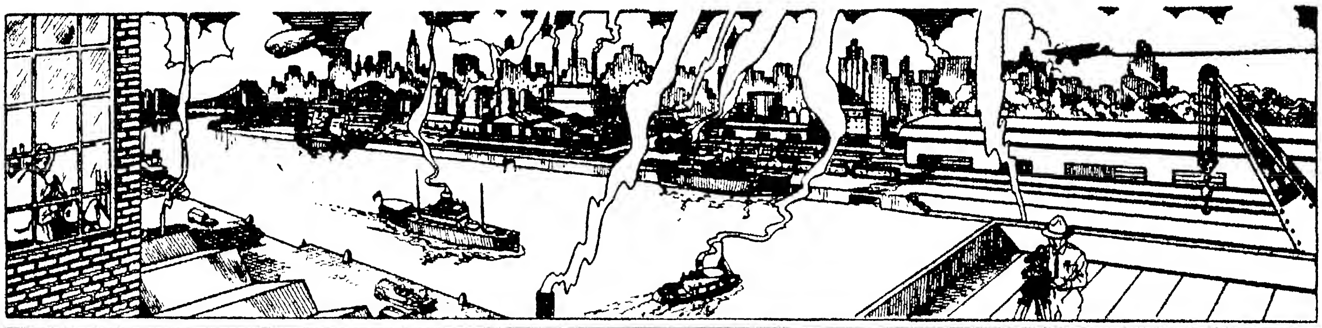
Much remains to be done. Though more types of glass and better glass are being made, the field of silica chemistry is awaiting further exploration. Even its physical nature remains in part a secret. Actually, glass is still an unpredictable material, not yet lending itself to precise measurement.

It is reasonable to believe that where there is so much research smoke there must be some development fires. One cannot witness glass withstanding hammer blows without realizing that its potentialities are great, nor can one see long flexible strands of the material without thinking that somehow, sometime, it will be treated like any other thread to fashion new fabrics with new uses. Let us not overlook the fact that glass is a modern material despite its long history. It is a material unique in combining all those qualities—clean and attractive appearance, durability, fire-resistance, and transparency—which are so eagerly sought in other materials. We need to alter our conception of it. Then things will happen faster.

[a]Scientific American, July, 1935, page 3.

Photographs courtesy: Owens Illinois Glass Company; Libby-Owens-Ford Glass Company; Corning Glass Company; Hartford-Empire Company; and Pittsburgh Plate Glass Company.

Plate glass being ground and polished in the modern manner, under a battery of rotating disks



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

A. E. BUCHANAN, Jr.
Lehigh University

Dr. Clyde Fisher, the many-sided curator (botanist, astronomer) of the new Hayden Planetarium in New York, with the lecture staff of the institution. Left to right: Miss Dorothy Bennett, Mr. Arthur L. Draper, Miss Marion Lockwood, Mr. William H. Barton, associate curator. Above is represented the constellation, not of Cupid, but Sagittarius, on the planetarium dome

Auto Parts from Soy Beans

ONE of Henry Ford's dreams—that of raising the raw materials for automobile manufacture on the farm—takes a step toward actuality with the construction of a huge mill for making molded automobile parts from soy-bean plastics, now nearing completion at the Ford River-Rouge plant. The completed mill fully equipped has a projected cost of approximately 5,000,000 dollars.

The first machine units, including storage tanks, giant mixers, and presses, are now in place and are turning out test parts. Actual production of parts will be started as soon as the necessary machinery can be installed.

The molding plant will require 86,000 square feet of floor space. It will be housed in a steel structure two city blocks in length and containing several balconies as well as a long open area for molding presses. Mixing of the plastic material will be carried out in the balcony structure through a series of 26 mixers. The parts will then be turned out from the long battery of presses. It is estimated that the completed factory will have a capacity of more than 100,000 parts a day.

When completed, the plastic mill will be the largest factory in the world devoted to processing farm products for industrial use.—*A. E. B.*

Photo-Cell Output

IN response to queries by several readers, Mr. John H. Radu, author of the article "Make Your Own Light-Sensitive Cells" which appeared in our October number, writes us that tests of the type of cell described show that a current output of approximately two milliamperes per square inch of cuprous oxide plate may be expected.

FINGERPRINTS

THE largest collection of fingerprint data in the world now reposes in the Federal Bureau of Identification of the Department of Justice in Washington. The fingerprint records of 5,154,254 persons were on file there July 31, 1935.

Measles and Whooping Cough Decrease

MEASLES and whooping-cough, both serious diseases of childhood, are on the decrease, it appears from figures reported by Dr. Haven Emerson, of Columbia University, to the American Public Health Association.

The decrease has been particularly marked during the past five years, Dr. Emerson found. Deaths from both diseases and the number of cases of measles have been much fewer.

This is not because of any improvement in measures to control the diseases, Dr. Emerson indicated. Instead, the decrease appears to be the result of a change in the age distribution of the population. Fewer children and more adults in the United States within the past decade is reflected in the decline of these childhood diseases.—*Science Service.*

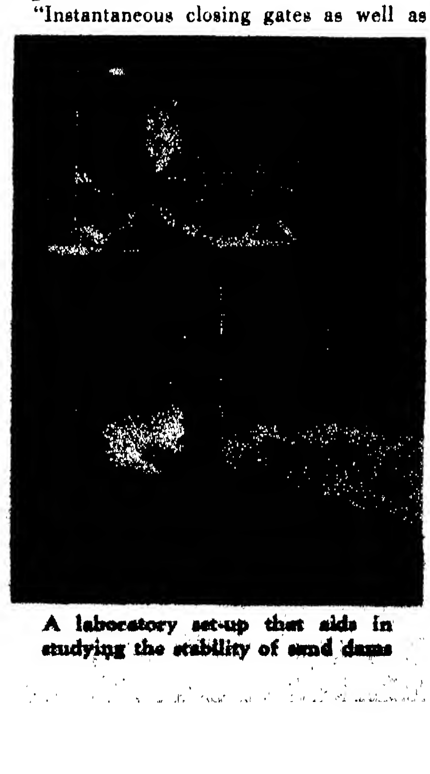
Canal System on Upper Mississippi Studied

WATER flowing through glass-walled channels in the hydraulic laboratories of the University of Minnesota, at Minneapolis, is aiding engineers to determine the stability of sand dams being constructed in connection with the canalization for navigation of the upper Mississippi River.

The 60-foot long experimental flume has glass on the sides and bottom through which hydraulic engineers observe swirls, eddies and flow conditions with a wide range of water velocities and depths.

High water and flood conditions can be simulated by the equipment, according to Prof. L. G. Straub of the engineering experiment laboratories, under whose direction much of the hydraulic research is being carried out.

"Instantaneous closing gates as well as



A laboratory set-up that aids in studying the stability of sand dams

head-regulating gates are arranged at both ends of the channel, thus providing the possibility of studying a large variety of flow phenomena. The arrangement allows for the simulation of flow conditions in canals and rivers, the effect of abrupt or gradual gate opening at ship locks, and the like.

"The introduction of coloring matter into the water at various points along the stream assists materially in studying flow conditions.

"The channel is provided with a sediment-intercepting basin at the discharge end so as to allow for observations of the erosion, transportation, and deposition of sediment by flowing water.

"Although the apparatus is quite new, a number of investigations have been made therein which indicate the variety of tests which are possible. These include studies of the stability of the sand dams being constructed in connection with the canalization for navigation of the upper Mississippi River, the design of flood regulating works for various hydroelectric developments, and the like."—*Science Service.*

Windowless Building

THE photograph of the windowless office building of the Hershey Chocolate Corporation on page 270 of our November issue was made especially for us by the York Ice Machinery Corporation whose air conditioning system has been installed in this building. We regret the oversight which caused omission of the credit line.

PROGRESS In This Age Of Science
As Told to SCIENTIFIC AMERICAN

By WILLIAM B. STOUT
President, Stout Engineering Laboratories, Inc.

WHEN we finally "unhitch 'Old Dobbin'" from the automobile we are going to make some giant strides in automotive transportation. It may have been all wrong as far as the horse-drawn vehicle is concerned to have the "cart before the horse," but it will not be long before it is proved to be equally wrong to have the car behind the horsepower. When the day of the rear-engine car arrives, the driver will have infinitely better vision from all angles. The automobile will be lighter and more efficient and yet safer, the ride will be easier, and the body will be more roomy without sacrificing maneuverability. In fact, there will be a large gain in this respect as well as in comfort.

Along with the horse-drawn vehicle tradition we have such things as the uncomfortable transverse seat for passengers and driver. The automobile today is the only long-distance vehicle in which passengers are compelled to sit bolt upright in a strained position hour after hour whether they like it or not. The rear-engine car will change all of this. The strange part of it is that we have had to suffer many inconveniences because we have insisted on placing the engine in front. The break is beginning to come, however, and it will not be long before the current type of automobile will be just as obsolete from a transportation standpoint as the horse-drawn vehicle which it has so faithfully followed in many respects over the last 25 years.

Mightiest Diesel Locomotive

ANNOUNCEMENT by the Santa Fe that it has just taken delivery from the Electro-Motive Corporation of the most powerful Diesel locomotive ever placed in service—and that the new giant, if exhaustive tests prove successful, will haul the road's crack flier, *The Chief*, between Chicago and California, on a faster schedule than at present—marks another dramatic milestone in the spectacular drive by the management of major American lines to regain for the rails their old place in the sun with the traveling public.

With a conservative rating of 3600 horsepower, a weight of 240 tons, and approximate over-all length of 127 feet, the Santa Fe's new "power house on wheels" overshadows any previous application of Diesel power to light streamlined trains, to rail cars, or to relatively light switching locomotives. Actually it is a multiple unit of two identical sections which can be operated singly or together, or coupled to any desired number of similar units, all of which can be controlled by a single operator. It thus marks the longest step that has yet been taken in exploring the possibilities of applying the flexible and economical power of Diesels to any kind of train on main line service. The units are arranged for double-end operation, with an operator's cab and control station at each end. From these control stations the driver is afforded a clear view ahead and of both sides of the track.

Motive power of each unit of the locomotive is supplied by two Winton V-type, 12-cylinder, high compression, two-cycle oil engines. Since each engine is conservatively rated at 900 horsepower, the two units provide a total of 3600 horsepower, all available for traction purposes.

These engines are extremely light in weight, weighing less than 20 pounds per horsepower, a remarkable weight-saving over the usual type of Diesel engine that has been obtained by incorporating newly designed principles of engineering and construction. The fuel used is a comparatively inexpensive Diesel fuel oil, 1600 gallons of which can be carried.

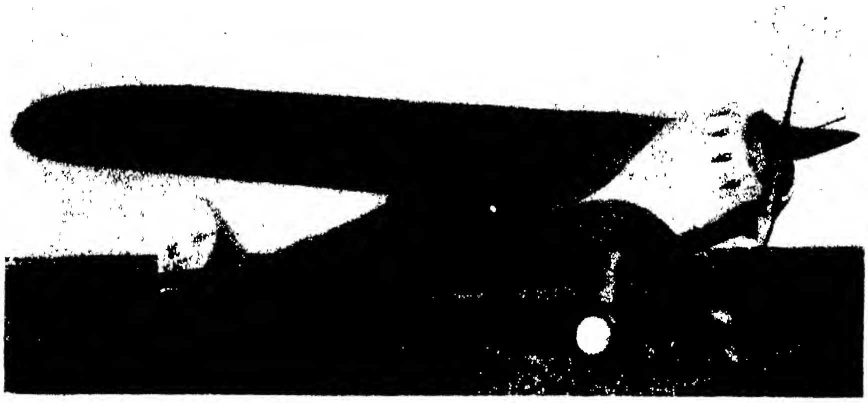
Among the many new features developed especially for this modern type of locomotive is the steam generating unit for heating and air-conditioning the cars of the train. This is a light weight, compact, automatic unit, drawing its fuel from the same storage tanks that supply the main power plant, and having an evaporation capacity of 2000 pounds of water per hour at a working pressure of 200 pounds. The twin locomotive boiler water capacity is 2500 gallons.

The multiple-unit Diesel locomotive described above

Ethiopian the Oldest Language

ETHIOPIAN is the oldest language in that it has departed the least in its form from the original proto-Semitic, according to Dr. John P. Harrington, ethnologist of the Smithsonian Institution. Even the Hebrew in which the Bible is written has gone a long road of development beyond the modern Ethiopian. Hidden away in the African Alps, this old language still survives, uncorrupted by the centuries.

Let us take for instance the name of the



Cessna high-wing monoplane, winner of the Private Owner's Race

letter "a." This letter in its capital form still preserves today very much of its original pattern, which was that of a crude figure of the head of the ox. The descending strokes at the bottom of capital "A" are the horns of the head of the ox. Ancient Egyptian has a very similar symbol. The natives of central Celebes have similar carvings of the head of the water buffalo on the beams of their houses. Now the name of this letter and of the ox in the primitive Semite, spoken 5000 B.C., is "alf." In ancient and modern Ethiopian the name "alf," ox, is still on the tongues of the people. But in the Hebrew of the Bible it is already "aalef," ox, the word having been distorted into two syllables and starting with a lengthened vowel.

Ethiopia is the oldest Christian country, having been completely converted to Christianity at a date somewhere after 200 A.D. The Ethiopians were a thoroughly Christian country under a heavy priesthood at the time when Italy was persecuting Christians under the Roman emperors.

Tuning up a fast racing plane just before the Thomson Trophy Race

A Race for Private Owner Planes

WHILE no speed records were established at the Cleveland Air Races, the introduction of a special race for private owner planes—stock models—had real significance. The National Aeronautic Committee, in inviting manufacturers to participate in this new type of race, pointed out quite correctly that the American market for private planes was opening up, and that the contest was very timely.

There were five tests, four of which were run about a week before the races. The rules for these tests were as follows:

1. Obstacle Take-off and Landing.

Take-off and landings over a light 50-foot barrier. Points allowed, 1 point each for each 5 feet less than 1000 feet.

2. Maximum Speed.

Tests over 3-kilometer course. Points allowed, 2 points for each mile above 70 miles per hour.

3. Speed-Economy Run.

Closed 150 mile circuit, with at least two turning points and stops. Points allowed in accordance with the following formula:

$$\frac{(\textit{Useful Load})\ (\textit{Miles per gal.})\ \dfrac{\textit{Average Speed}}{\textit{Maximum Speed}}}{70}$$

4. Closed Course Speed Sprint

Five laps around a 5-mile closed course, take-off and landing over a 10-foot barrier in a lane 100 feet wide. Points allowed: Take-off and landing, 1 point for each 100 feet from 1000 foot mark. Speed 1 point for each five miles per hour.

5. Private Owner Features

Points allowed for field of view; additional passengers beside pilot; side by side seating; enclosure of cabin; starter; baggage; dual control; adjustable trim; landing lights; heating; ventilation; tail wheel; adjustable seats.

The winner of the race was the Cessna which is illustrated in our photograph. The Cessna is a remarkably clean high-wing cabin monoplane, with both wings and landing gear entirely of the cantilever type. It is a four-place machine, with a wing area of 180 square feet. Its gross weight is 2200 pounds, and it is powered with a Warner Super-Scarab engine of 145 horsepower. Maximum speed is 162 miles an hour. In the fuel economy race, the Cessna made 13.2 miles to the gallon of gas, and it landed over a 50-foot barrier and came to a full stop in only 658 feet. It made a take-off of 910 feet over the same barrier.

The Cessna scored 62 points out of a possible 80 on the private owner features.

The reason we are dwelling at such length on the achievements in the private owner race is because the points were allotted by impartial and capable judges. Their findings indicate that American aviation already has to offer the public a plane of high performance, good fuel economy, and excellent private owner characteristics. *A. K.*

A Social Register of Flying

WE welcome the appearance of the "Air Pilots Register," probably the first work of its kind that has appeared anywhere in the world. It contains a list of American War Aces, the holders of the Distinguished Flying Cross, a Roster of the Caterpillar Club, a complete directory of airports in various states with adequate descriptions of each, a complete registration of private flying insignia, and other material of interest to those engaged in flying either professionally or from an owner's point of view. Some of the insignia which are carried on their planes by private owners are really beautiful. The publication is another evidence of the fact that private flying is definitely here.—*A. K.*

A Portable Aircraft Engine Test Stand

THE public, flying at three times the speed of a railway train and with equal regularity, does not realize the growth in airplane maintenance and servicing that has made such operation possible. Airline operators and manufacturers are constantly finding new wrinkles. Thus, General Airmotive Corporation has introduced a portable test stand for aircraft engines, which is of real utility in the field. This comprises a one-ton truck on which an engine test stand is mounted. The stand itself is constructed of obsolete airplane parts, can be removed from the truck in a few minutes, and is

Portable engine test stand, mounted on a light truck

capable of taking any engine from a large Wasp down to a small Velie engine, merely by changing the plate on the motor mount. This is a simple device, but one for which many aviation people working under pressure of time in the field will be thankful. —*A. K.*

The World's Fastest Landplane

It was a great disappointment, at the Cleveland Air Races, that the Hughes racer was not finished in time to compete. The fast racing planes were the same that had entered the classic speed contests in 1934, and as a result no records were broken and speeds attained were even a trifle lower than in previous years. The Hughes racer, had it participated, would have undoubtedly "walked away" from the field.

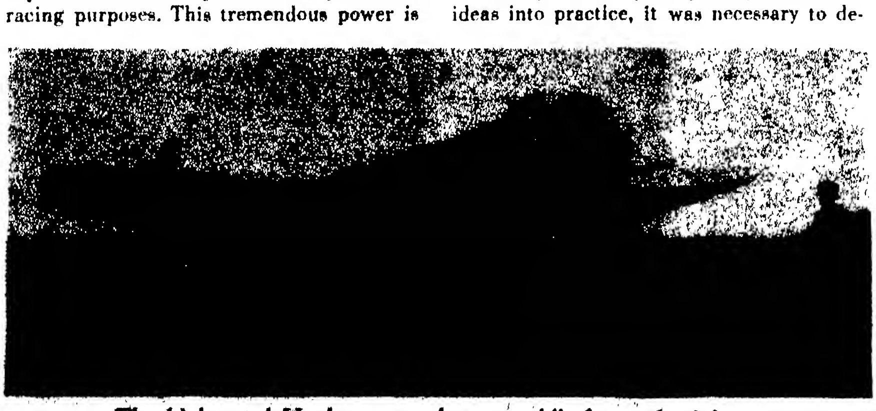
The world's landplane record was established at 314.319 miles per hour by the French pilot Raymond Delmotte, on December 26, 1934. Lieutenant Francisco Agello, piloting a Fiat motored Schneider Cup racer established the world's seaplane record of 440.2 miles per hour on Lake Garda on October 23, 1934. Soon after the Cleveland races, Mr. Howard Hughes, backer of the new design, himself piloted his craft to a new world's record of 353 miles an hour. This figure, while not yet confirmed by the Féderation Aéronautique Internationale, is nevertheless perfectly reliable.

Mr. Hughes is a young man, who received a technical education at Rice Institute, Texas, succeeded his father in the oil tool business and amassed a large fortune. He was afterwards equally successful in moving picture production at Hollywood. It is a fortunate thing for American aviation that a man of his enthusiasm and means has taken up airplane racing as the latest of his hobbies.

It may be asked: Why does the landplane record stand so much lower than the seaplane record? The first reason is that the seaplanes were developed for the Schneider Cup by governments, with no practical limitation on cost and power, and were powered with engines turning up 2500 horsepower or more. The second is that seaplanes alight on water and can stand more landing speed and less wing area; the smaller the over-all dimensions, for a given power, the greater the speed of an aircraft.

At the same time, the Hughes monoplane is fast enough. It is a single seater, open cockpit, low wing monoplane. The power plant is a Pratt & Whitney twin row Wasp, capable of delivering 1000 horsepower for racing purposes. This tremendous power is employed for a machine only 27 feet in span, and 140 square feet in wing area. To absorb the high power, a large diameter Hamilton-Standard controllable pitch propeller is used, and this explains the somewhat stilt-like appearance of the machine. The wheels retract into wells on the under side of the wing.

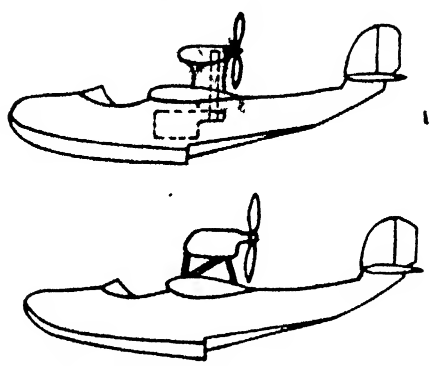
The Hughes monoplane is quite a rugged craft. On its last run over the speed course in Los Angeles, a long streak of black smoke indicated engine trouble and the plane reeled off its course. One gasoline tank had been exhausted and another failed to feed the motor. In the ensuing forced landing, the retractible landing gear was only half-way down, yet the damage was restricted to a bent propeller and a torn fuselage. Mr. Hughes suffered no injury. —*A. K.*



The high-speed Hughes monoplane—world's fastest landplane

Belt Drives for Flying Boats?

In a flying boat of the private owner type and of small dimensions, the problem of propeller clearance necessitates the placing of the engine well above the hull. In a typical arrangement, the engine is mounted on a strut framework and the propeller is of the pusher type. Even though the clearance between the propeller and the top of the hull is kept at a minimum, the motor is bound to be high above the hull itself. The private owner flying boat is apt to be expensive, and the Air Commerce Bureau (still actively concerned with the cheapening of flying equipment) conceived the two following ideas: 1. Use an automobile engine of relatively high weight, but low price. 2. Place the engine within the hull (with obvious advantages in accessibility and maintenance) and drive the airscrew by means of some type of transmission.



***Top:* Belt drive for a flying boat, with engine in hull. *Below:* Standard practice; the engine on struts**

As a preliminary to putting these two ideas into practice, it was necessary to design a suitable drive and speed reduction between the motor and the airscrew. The use of gearing and shafting did not look promising, because of weight and mechanical difficulties. Then the Casey Jones School of Aeronautics hit on the expedient of a belt drive. Under the auspices of the Department of Commerce, and with the co-operation of a belt manufacturer, the Casey Jones School has completed a successful 300-hour run of a belt-drive installation, which is illustrated in our photograph. The experiment was conducted under operating conditions, since the tests were made out-of-doors, and the installation was subjected to dirt, dust, and varying weather conditions.

A practical aircraft belt drive

An ordinary automobile engine, developing 88 horsepower at 3800 revolutions per minute, was used continuously in conjunction with a belt driven airscrew, and the cost of replacement of engine parts after the 300-hour test was only about 50 dollars.

To reduce belt slippage to about 3 percent at full engine speed, six belts were employed. With a single belt, slippage was prohibitive. At the engine, the pulley was bolted directly to the flywheel; above, the six-grooved pulley was mounted in simple bearings. Duralumin pulleys were used at first, but it is apparently better to resort to steel pulleys.

The belt must have special characteristics. A belt never fails because it lacks mere strength. It fails because the flexing over the pulleys introduces high stretch and tension at the outer side, high compression and shortening at the inner side. Therefore the way to design a belt for these severe conditions is to place the main strength in the center portion of the belt, and to have the outer portions made of a flexible material capable of being stretched or compressed indefinitely without much wear.

Whether the experiment will be continued by actual embodiment in a flying boat has not yet been determined, but it certainly opens up interesting possibilities.—*A. K.*

Waterproof Glue Film

An important new development in the manufacture of veneers and plywood which has recently achieved success consists in the replacement of the water-soluble glue heretofore used by a synthetic resin which gives a waterproof and mold-resistant

Making a mold of a delicate art object, using crisscrossed strips of ordinary gummed paper. See the text

bond of enormously increased strength, says *Industrial and Engineering Chemistry.*

The idea of using phenol-formaldehyde resins as the adhesive bond in plywood is not new, but previous attempts to apply the idea have met with limited success. The problem has been solved by preparing a special type of resin in the form of a thin sheet. This product, known commercially as Tego glue film, has been developed by the Resinous Products and Chemical Company of Philadelphia, in conjunction with the Theo. Goldschmidt A.-G., Essen, Germany, and is being manufactured and used in this country on a large scale.

The new type of plywood veneer is being specified by manufacturers of furniture, radio cabinets, airplanes, and so on, and not only will replace the older type in many cases, but is expected to open up important new uses for plywood. Its use in the manufacture of pre-fabricated houses is engaging serious interest, and is of great importance to the immense fir plywood industry of the Pacific Coast. This new resinous glue in sheet form is also finding application in such products as the bonding of laminated phenol-formaldehyde panels to wood, and of thin wood veneer to fireproof asbestos board.—*A. E. B.*

CANNED BEER

ONE can company, it is reported, has installed facilities for turning out 50,000,000 beer cans monthly by the end of this year. The canned beer idea seems to be catching on at a tremendous rate.

Delicate Art Works Copied by Four Cent Process

BEAUTIFUL sculptured art works, that never before could be reproduced for fear of damaging the delicate surface, can be copied safely by an ingenious and inexpensive new process. The process, devised by Lamont Moore—of the Newark Museum (New Jersey) staff, shown in the illustration—has been successfully tried first in making a cast of a famous ancient Indian sculpture, the head of a Mayan corn god belonging to Peabody Museum, Cambridge, Massachusetts.

Knowing that beautiful colors painted on the corn god's image would be ruined if oil or grease were applied, as is necessary in making an ordinary plaster of Paris mold, Mr. Moore determined to find a way to produce the copy that his museum wanted for exhibit.

His process, evolved after many experiments, is to stretch several layers of ordinary paper handkerchiefs over the surface to be copied. Over this soft layer which protects and fits to the sculptured contours, he crisscrosses narrow gummed paper until three layers of the gummed strips have been built up over the features, forming a perfect mask. The mask is lifted from the sculpture, and greased, shellacked, and plastered in preparation for use as a mold.

Cost of making such a mold, Mr. Moore finds, is only about four cents, and some 15 reproductions can be cast from it. An experienced worker can make a mold by this process in eight hours or less.—*Science Service.*

Surface Illuminator Aids Microscopists

WORKERS on opaque materials under the microscope have been complaining for a long time about the difficulty of evenly lighting their specimens without a battery of lamps distributed around the stage.

Better light for the microscopist

The accompanying illustration shows a new surface illuminator, developed by Bausch and Lomb, which supplies a well-balanced annular cone of light. It can be varied in both intensity and incident angle. It will reveal details in irregular surfaces as no previous illuminating source has.

The little instrument is simply a ring holding six bulbs spaced equally around the inside of the ring with individual reflecting surfaces back of each bulb. The ring slips over the microscope objective and is held in position by an extension rod suspended from a clamp attached to the eyepiece adapter, which may be either vertical or inclined.

The small bulbs are 2.5-volt, 0.3 amperes and are made in either clear or daylight glass. The light may be dimmed to any degree of intensity by means of a transformer with variable resistance and switch for 110-volt, 50- or 60-cycle, A. C. For direct current a converter is supplied.

At present the illuminator is made only for 48-mm, 32-mm, and 16-mm microscope objectives. It is particularly useful with any conventional monocular laboratory microscope whose body tube is 35- or 39-mm in diameter, or with the Toolmaker's Microscope.

Little Girls Turn Blue

FOR the rest of their lives 10 little girls will face the world with blue or slate-gray complexions. Within the last year these girls, as well as five boys, have developed argyria, a discoloration of the skin or tissues resulting from the free use of silver preparations. At present, no treatment for the condition is known.

Dr. L. Edward Gaul and A. H. Staud, New York City, discuss the alarming increase in argyria in the *Journal of the American Medical Association.* Seventy cases of this permanent discoloration of the skin have been reported. The number of cases has increased more than 100 percent in the last five years, these medical workers state.

The disfigurement of the 15 children mentioned, all of whom are under 10 years of age, followed the use in the nose and throat of solutions containing silver for the treatment of colds and allied conditions. Argyrol, collargol, and neo-silvol are the silver compounds involved, according to the report of these two scientists, both of whom are connected with the New York Post Graduate Medical School and Hospital, Columbia University. The human body, state Dr. Gaul and Mr. Staud, can retain only so much silver—an equivalent of eight grams of silver arsphenamine. If more than seven grams from this or any source is taken in argyria develops.

The discoloration first appears on the face, neck, hands and the half-moons of the finger nails, as a result of the chemical action of the light on the retained silver.—*Science Service.*

New Brake Tester for Car Owners

THE King Pin Test-A-Brak is the newest recording device for testing the condition of an automobile's brakes. Its operation is so simple that any automobile owner can make his own recordings. The new device indicates whether brakes are in a safe, doubtful, or dangerous condition.

Test your own brakes

It records the approximate distance required to stop a car at a speed of 20, 30, and 40 miles per hour. There are no bulbs, wires or cables to get out of order. The unit is self-contained in a Bakelite molded case. It is manufactured by the Allbestos Corporation.

INSULATING CEMENT

ON page 206 of our October number was described an insulating cement, Sonittep, and the statement was made that 1000 pounds of this cement will cover 50 square feet to a depth of one inch. This was a typographical error; the statement should have been that 100 pounds of the cement will cover 50 square feet to a depth of one inch.

WHY?

WITHIN the past few years some men of science have endeavored to understand the ultimate nature of things, and some of them their meaning. Thus, what is spoken of as the "philosophy of science" has attracted widespread attention, rather more without scientific circles than within—possibly because of the linkage of these thoughts with faith. Most scientists intuitively feel that the search for truth—final, ultimate truth by means of the methods of the scientist is either far beyond our present reach or forever unattainable. Therefore they do not try to find out *why* things in Nature work or why they exist, feeling that these questions are beyond the province of science. Their first aim is to find out *how* all things work. A similar thought of defeatism in the solution of the problems of the philosophy of science is expressed in the following verse written by a reader of this magazine, Anna Ball, of Colton, California:

THE QUESTIONNAIRE

By Anna Ball

"What is this, Mother?" "The rain, my child."
The desert lupin looked up and smiled.
"Mother, there shoots a strange, sweet thrill along my roots.
What is 'rain,' Mother? How is it made?
Mother, the dim sky makes me afraid.
Mother, why is it I feel so glad
When all the wide world's dim and sad?"
The mother answered: "Because of the rain."
"What is 'rain,' Mother? Tell me plain."
The mother answered: "*This* is the rain."
"But what *is* it, Mother? I have to know."
The Mother answered: "H_2O, hydrogen, oxygen—H_2O."
"But Mother, that's no *plainer*, you know."
"You be satisfied because it's *so*."

TRIBOROUGH BRIDGE

BRIDGES have played a tremendous part in the march of progress. Today their significance is greater than ever before due to the serious traffic problems brought about by the steady increase in the use of automobiles. In thickly populated sections where traffic congestion is an accepted thing, each new bridge is welcomed by motorists with a sigh of relief. This has been the case with all bridges around New York City, but the Triborough Bridge, across the East River, has particular value because of

its strategic position at the focal point of three boroughs.

This bridge will be a new arterial highway for vehicular and pedestrian traffic between the boroughs of Queens, Manhattan, and the Bronx, connecting as well with Randall's and Ward's Islands over which it passes. The Queens to Bronx branch of the bridge will form a junction with the Manhattan branch on Randall's Island.

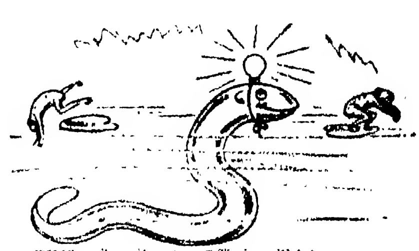
The bridge structure will consist of a suspension bridge over the East River, a vertical lift bridge over the Harlem River, through truss spans over the Bronx Kills and adjacent railroad yard, together with plate girder viaduct structures on the Queens and Manhattan approaches, over Ward's and Randall's Islands and Little Hell Gate. These structures, comprising the bridge proper, will aggregate a total length of three and one half miles. Also included in the project are highway connections in the three boroughs totalling 14 miles of modern highway construction.

The bridge between Queens and the Bronx will provide for two roadways, each 43 feet 6 inches wide, on a single deck, for a total of eight lanes of traffic. The Manhattan branch will provide two three-lane roadways, 33 feet 6 inches wide for a total of six lanes of traffic. Sidewalks for pedestrians will be provided throughout. The suspension bridge over the East River will have a main span of 1380 feet and side spans of 705 feet. The deck will be suspended at a clear height of 135 feet above the water level from two parallel wire cables of 20¾ inches diameter. The cables are to be spaced 98 feet apart and will pass over the tops of two 300-foot towers. The anchorages contain a total of 140,000 cubic yards of concrete. A total of approximately 62,000 tons of structural steel will be required for the entire bridge structure, including the viaducts and truss spans.

Concrete piers have been completed on the Queens Approach and the steel viaduct structure has been erected. The piers and viaduct structure are also in place on Ward's Island. The remaining work to complete the project is being prosecuted vigorously and it is anticipated that the bridge will be open for traffic in the summer of 1936.

EELECTRICITY

ELECTRICITY can be ichthyologically produced, whereupon it might be considered as eelectricity. In the Aquarium in New York, for example, there is a six-foot length of *Electrophorus electricus*, or electric eel. This swimming central station



regularly supplies the necessary energy for lighting a couple of neon glow lamps thrice daily, says the *General Electric Review.*

The two two-watt neon lamps are attached in parallel to antenna loops atop two aluminum wires submerged at the ends

of the eel's 10-foot tank. At first the eel kept the lamps glowing much of the time, but then he became temperamental. Now he works only when tickled with a copper wire; and the tickling procedure is conducted at 11:30, 2:00, and 4:00 o'clock in the presence of spectators.

Only one side of the neon bulb is illuminated, showing the discharge to be direct current. Experiments have indicated the voltage to be from 125 to 200 volts.

SOLAR VARIATION

OBSERVERS of the Astrophysical Observatory of the Smithsonian Institution have finally proved that the sun is a variable star, that its heat varies from day to day and from month to month.

Reviving Oil Wells With Chemicals

CHEMISTRY has come to the aid of the oil industry since it was discovered that a dormant or exhausted oil-well may be revived by pumping hydrochloric acid down the pipes to the floor of the oil pocket. The acid attacks the calcareous formations developing considerable gas pressure and ejecting oil not readily obtained by pumping.

But here the chemist is called upon to perform another bit of legerdemain—the acid must not attack the iron of the down-pipe or the pressure pumps, but must act upon the calcite rock. To obtain this discriminatory action, the chemist uses substances that he calls inhibitors. Just as there are catalysts which accelerate certain chemical reactions, so these substances retard the action on the metal. In this case, however, the selective action is of great importance, as it is not desired to retard the action on non-metallic substances.—*A. E. B.*

Were Our Ancestors "Magnificent Savages?"

A SURVEY by Prof. A. V. Vallois of present knowledge relating to the diseases of prehistoric man, communicated to the Institut de Paléontologie Humaine, appears in *La Révue Scientifique*, Oct. 27, 1934. The general conclusion is that it is an error to suppose that our ancestors, living a wild and savage life, had acquired a greater resistance to disease than ourselves. There is, however, a difference in the diseases which were most prevalent, and this distinction is to be observed not only as between modern man and neolithic man, but also as between neolithic man and paleolithic man. Rickets does not appear to be present in paleolithic man, but there is abundant evidence of rheumatoid arthritis, attacking the vertebrae as well as the limbs. It becomes increasingly common in the neolithic and bronze ages.

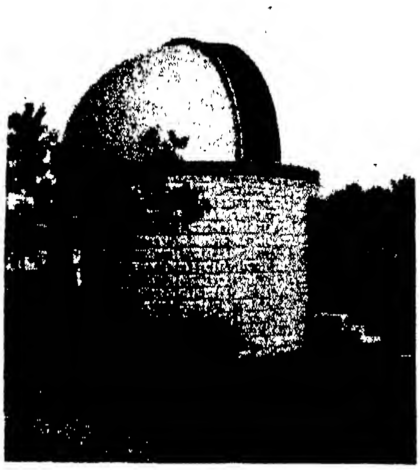
Evidences of wounds are not very common in the paleolithic period. In the neolithic age they become more frequent and are found in all the bones. Two facts are noticed —the presence of flint arrowheads in the injuries, especially in the dorsal vertebrae,

(Please turn to page 335)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

O. R. YOUNG and Son are machinists at Roanoke Avenue and Fifth Streets, Riverhead, N. Y., their letterhead indicating that they do welding, sheet metal work and so on, and they have made a pretty swanky observatory for their own use. We show two pictures of it. "The observatory," O. R. Young writes in answer to our bid for more information, "is 16 feet in diameter on the inside and is made of building blocks. The dome has a wooden frame covered with Sislecraft paper and 20-gage galvanized sheet, soldered. The dome turns on an angle-iron circular track on ten 8" flanged wheels. It is turned by hand with a crank mounted on the side wall with a pair of bevel gears and a shaft and pinion which meshes in the circular rack fastened to the bottom of the dome. The hatch slides on a circular angle-iron frame, and is worked by a hand chain with worm and gear connected to the rack on the hatch by three lengths of shaft with universal joints between each piece.



The Young Observatory

"We did not make the objective lens. The objective is of 8" aperture with a focal length of 130". The tube is seamless and made of a magnesium aluminum alloy 1/8" thick, which makes it light and rigid. The fittings are of bronze.

"The equatorial is made of steel, fabricated by the electric arc. Both the declination and polar axis shafts are carried on Timken precision bearings. The circles are bronze, 16" in diameter. The hour circle is graduated to 1^m and the vernier reads to 5^s. The declination circle is graduated to 15′ and the vernier reads to 1′.

"The equatorial is mounted on a 10" extra heavy pipe which goes into the ground about five feet in about four yards of concrete. There are provisions in the head for adjustment both ways for setting the polar axis.

"The electric drive, which is of our own design, consists of a box made of 1" cold drawn steel 7" by 7" by 15", with two partitions, making three compartments in which are mounted in a series three 40-to-1 worm drives, and one variable speed friction disk, which are mounted on Timken bearings.

"The power is a $\frac{1}{8}$ h.p., 1800 r.p.m., 1-phase synchronous motor driving the first worm reduction. There is then interposed the variable speed friction disk. The driver is a steel disk held in contact with the edge of the driven Formica disks by spring tension. The driven disk slides on its shaft to give the variation in speed, and is controlled by a graduated dial on the outside of the box. All the gears run in oil.

"On the last worm gear shaft, which extends out through the end of the drive, is a bronze drum with a half round thread cut on it of the same pitch as the diameter of the Monel cable, which runs up over a grooved sheave on the worm shaft on the equatorial, and then down through the column, with a weight on it. The drum has a ratchet for winding the cable on it, and holds enough cable for about 4 hours' running.

"You will note from the photograph that we have a polarizing eyepiece for solar observation. This screws in place of the regular eyepiece holder. This we made from aluminum castings, mounting four black glass flats inside on a 57° angle.

"Another thing is a sidereal clock which we made, a picture of which I am enclosing. We bought a No. 68 Seth Thomas movement, took off the train of gears which moves the hour and minute hands, and cut another set of gears with a compound gear 1-to-2 for the hour hand drive. These we mounted on a brass plate which we screwed to the front frame of the movement and which gave us a 24-hour clock. The face is aluminum and the figures and graduations are filled with black Duco. The case is arc welded steel sheet with screwed bronze doors, which makes it practically dust or air tight."

JUDGING from letters received, also from your scribe's own recollection, most beginners find that the knife-edge test leaves them with severe headaches from eye strain. For the first year or so this test is generally nerve-wracking, after which it seems to flatten out so that looking at the shadows as long as one wishes to do so is no harder on the eyes than looking at the scenery at a bathing beach or at a pound of butter. Perhaps the following hints will help:

The first thing is to place one's self in a completely comfortable, relaxed position, and get into a placid, limp, easy-going frame of mind. To make physical relaxation better possible, find out the height of your eye when sitting in a slouched position in a chair, and then place the test stand at the same height. Sprawl out your feet and arms when testing, and have your head well back, with no knots tied in your neck—relax. If possible, rig something for your left elbow to rest on, while manipulating the knife-edge, and have it at "just right" height, but this rest ought not to be on the same base as the knife-edge. Adjust the mirror so that the cone of returning rays is high enough above the table or board on which the knife-edge rests to permit you to get your chin on top, or else have the knife-edge come so near the edge of the table that your chin is not a factor.

The worst source of headache and nervous tension is trying to close the other eye when making the test, just as it is when using a telescope or microscope. Leave the other eye entirely open, as all microscopists and astronomers do; you will soon learn to forget or ignore the extraneous image on its retina—it is on the eye but not in the brain, as it were. Don't squint or screw up the eye you look with—just look with it as you would look off down the street, wide open, easy and naturally.

A third factor is psychological: At first you do not seem to see all you had hoped to see and, thinking that all others see everything, you become irritated at yourself and thus waste nervous energy—like a bunkered golfer. It may, therefore, help if you are told that no one sees everything in the test at first and, in fact, mighty few ever do become well enough trained to extract all the juice from it. Insight comes gradually, hence you should not expect to pick it all up, or even a quarter of it, within a month or so. You will see enough to work with, after playing with the test for a few sessions, but the education of eye and brain goes on practically forever.

If you are still doubtful about all that

The Young refractor. Note motor drive

has just been written, as applied to your own case, perhaps it will encourage you to hear that the writer had all of these troubles for months, and then none of them.

A YEAR or so ago we decided to find out, if possible, about the matter of alleged local figuring of optical surfaces by means of the heel of the hand, the thumbs, or the fingers, which some said was a myth and others said was a recognized method of the oldtimers. We referred the question to a professional, and he told us the tradition

Sidereal clock, Young Observatory

was based on a myth, and we believed him, stating that belief in this department. Pretty soon, however, we began receiving reports from various amateurs who were actually doing it. First it was Clyde Tombaugh, who has his name "writ large" on Pluto. He wrote, "One's thumb is an excellent tool to rub glass. The method is supreme for central hills." Then came S. H. Sheib of Richmond, telling us he used the middle finger of his hand and that the method worked well—too well, in fact, until he found that a little of it went quite a way. Next, Wallie Everest said he used the method regularly—fingertips, in his case; following which J. H. White of Cranford, N. J., mentioned his recollection of many years ago watching Alvin Clark working on a lens with a very broad thumb.

It began to look as though the ayes had it, and so we tried the method on a mirror which had a raised ring in the outer zone: mirror inverted, thumbs dipped in rouge mixture, and worked on the zone with short strokes as the pedestal was circumnavigated, knuckles used as a gage and control of distance in from edge. The zone came down and the method proved to be capital. Thus another fine theory is blown to ribbons by a mere fact; it may be true that a live meat local polisher ought not to work, but apparently it does. One thing to remember is that a little of this method goes a long way—otherwise your raised zone becomes a valley and your central hill a well. A little preliminary practice and gradual "feeling out" of the method will reveal its safe limits before any serious damage is done.

Horace E. Dall, 166 Stockingstone Road, Luton, Beds., England, submits the following suggestion for a direct method of measuring the angular diameter and physical appearance of certain stars. "So far as the writer is aware," he points out, "the following suggested method has not been put forward before and, although limited in application to about 10 percent of the sky, it may prove to be capable of giving information concerning the diameter and distribution of light on star disks unobtainable by any other known means.

"It is of course well known that the stars occulted by the moon apparently disappear instantaneously, due to their exceedingly small angular diameter. Actually, in the case of a certain number of stars, the time interval of occultation is by no means beyond the powers of modern electrical methods of recording. The method proposed is to direct the light from the star approaching the dark limb on to a sensitive photo-electric cell of the type which responds practically instantaneously to light variations. The small electromotive force generated would be conveyed to an amplifying unit employing thermionic valves, and the current from these would in turn be conveyed to a cathode-ray deflector and recording device similar to those employed for measuring and recording explosion pressures in guns. Alternately the current from the amplifier could be recorded photographically by an Einthoven string galvanometer having an extremely short vibration period or by an electro-magnetically operated vibrating mirror.

"The interpretation of the photographic record of an occultation (or reappearance) so obtained should present no special difficulty. Due allowance having been made for the inertia of the photo-electric cell and recording device, and for the eclipse of the aperture of the telescope, the remaining time interval and light curve will give a measure of the diameter and light distribution curve of the stellar disk.

"From a study of the theoretical occultation curve it does not seem unreasonable to assume that the method is capable of measuring stars down to an angular diameter of 0.0001", *i.e.*, 100 times smaller than the limit of the 50-foot interferometer. This corresponds to the size of our sun at a distance of 93 parsecs (at which distance it would appear 9.7 mag.) or to a star of Aldebaran's size at a distance of 7500 parsecs. It may be contended that irregularity of the lunar horizon will introduce errors; this is certainly true—but the probability of steep slopes is not great, and several occultations can be observed of each star. Furthermore, an analysis of the shape of the occultation curve may reveal slight irregularities of the lunar limb which can be allowed for. Another problematic point is the effect of our own atmospheric tremors; but the writer would suggest that this may not be a serious factor unless the *total* light received from the star is *very rapidly* and irregularly fluctuating.

"The possibility of causing artificial terrestrial occultations (from mountains and so on) is probably ruled out because of atmospheric tremors on *both* sides of the occulting plate. Although other planetary bodies would not be suitable for measuring star disks, owing to the nature of their surfaces, the method may be inverted and be made to supply information regarding the surface, or, for example, in the case of Saturn, the nature of the rings."

Here, then, is another chance for someone who is interested in electronics to work out something that will make him famous as a contributor to science. Three of our amateur fraternity are working on a similar problem in photo-electric telescope guiding—something which, if satisfactorily solved, will amount to a whole lot.

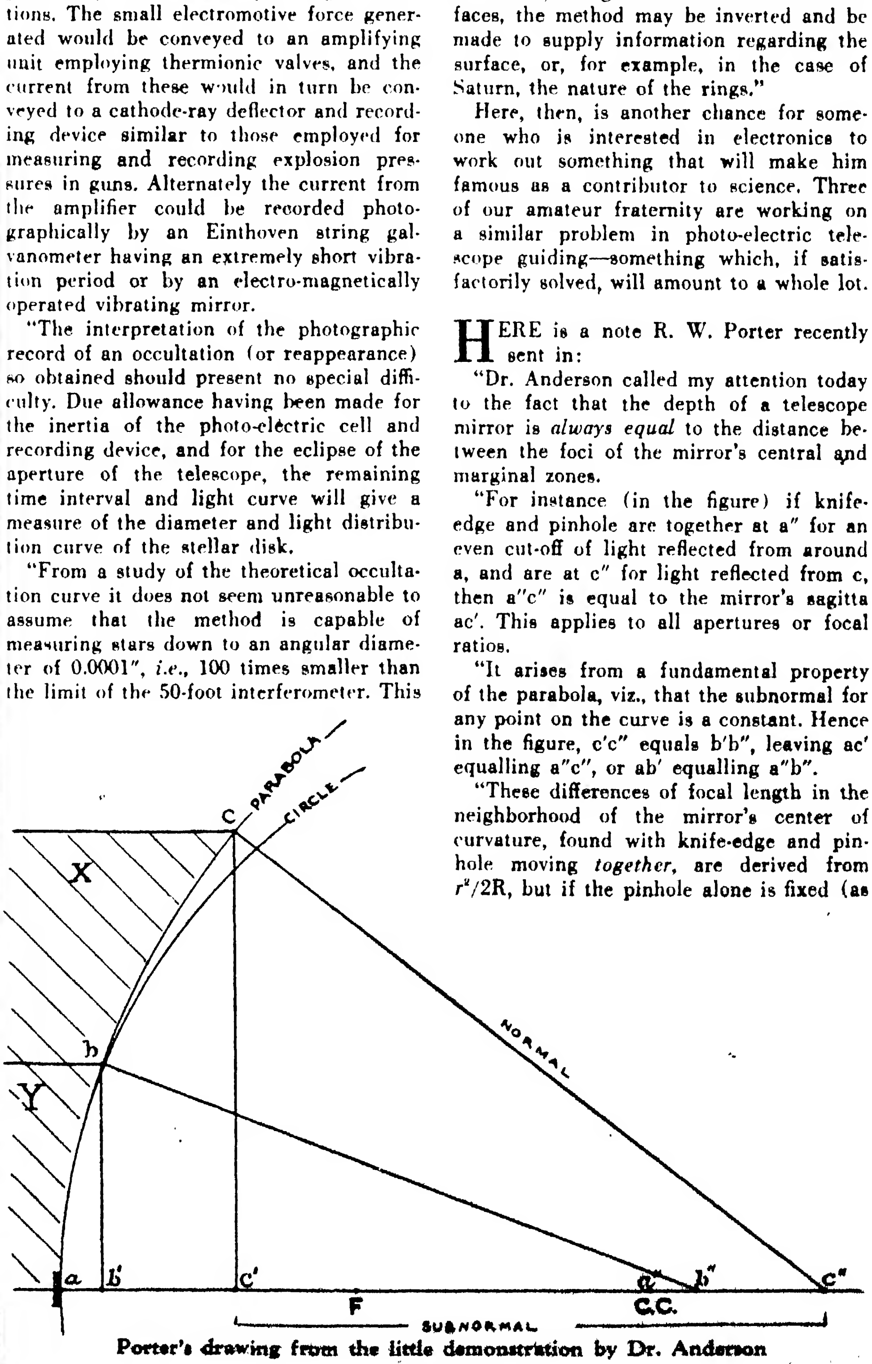
HERE is a note R. W. Porter recently sent in:

"Dr. Anderson called my attention today to the fact that the depth of a telescope mirror is *always equal* to the distance between the foci of the mirror's central and marginal zones.

"For instance (in the figure) if knife-edge and pinhole are together at a" for an even cut-off of light reflected from around a, and are at c" for light reflected from c, then a"c" is equal to the mirror's sagitta ac'. This applies to all apertures or focal ratios.

"It arises from a fundamental property of the parabola, viz., that the subnormal for any point on the curve is a constant. Hence in the figure, c'c" equals b'b", leaving ac' equalling a"c", or ab' equalling a"b".

"These differences of focal length in the neighborhood of the mirror's center of curvature, found with knife-edge and pinhole moving *together*, are derived from $r^2/2R$, but if the pinhole alone is fixed (as

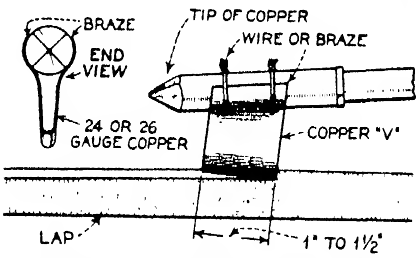


Porter's drawing from the little demonstration by Dr. Anderson

is customary among amateurs) r^2/R is used, giving twice these amounts.

"It had never occurred to me that a fellow could find this quantity quite independent of the formula, by simply laying a straightedge on his mirror and measuring its depth. I had never seen the point alluded to in any book on applied optics."

THANKS to Yankee ingenuity there are something under 1,000,000 ways to cut out the facets on pitch laps. The one in the

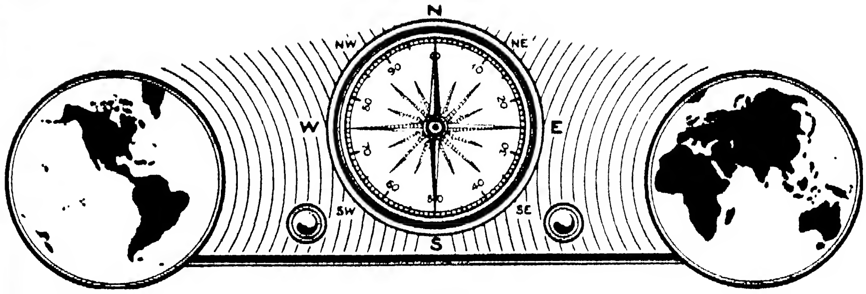


Mason's hot plow for pitch laps

accompanying drawing is by William A. Mason, 1303 Lakeview Ave., Lorain, Ohio. He says, "Do not try to make the groove full depth at the first stroke. Pull this tool through the pitch rather than push it. Do it slowly. With this tool there will be no chips or flakes." In the redrawn sketch the lap thickness was inadvertently exaggerated.

ABOUT once a month, for years, we have received letters much like the following: "Will you kindly advise me the names of books or publications containing data on the theory and construction of spectroscopes, also on their operation." So far as is known, there is no such book, and we wish somebody would write one covering just that ground in an all-around manner. Physicists pick up their knowledge of the use of spectroscopes by word of mouth, from older physicists, not from anything in print. Of course, it may be that such a book would not pay its way, unless a very high price were charged for it, but we believe many an amateur would lay down five simoleons for one if it were practical, understandable and interesting. A physicist we recently spoke to about the matter stated his belief that it would be possible to drop out the deep stuff (higher physics) which is so closely hooked up with spectroscopy, and still write a good book, but he was too busy to do so. The fact probably is that few who understand the use of spectroscopes (except manufacturers) could tell us how to make them. Maybe it would best be a two-man book, then, but we don't know the names of the logical candidates to write it.

LAST month we gave you a little advance dope on the forthcoming fourth edition of A.T.M. Various things, including our annual vacation and a little attack of the tummyache, have held us up and, at present writing (Oct. 14), the second proofs have just been returned to printer. So it looks as if the book ought to be ready by another month. It will be no larger but certain out-of-date parts have been replaced by what we think is better stuff, a lot of small corrections have been made, and quite a few new notes substituted for older ones.



WORLD-WIDE RADIO

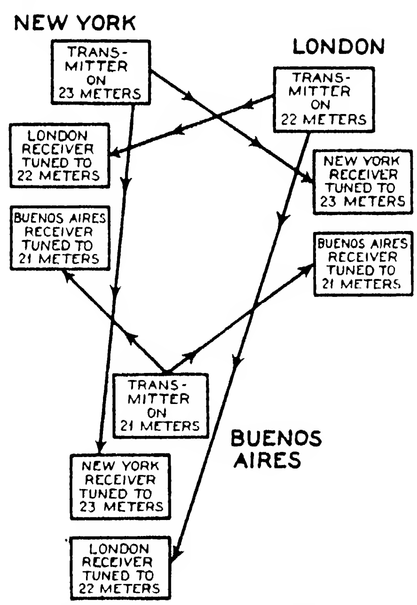
Conducted by M. L. MUHLEMAN*

Radio Telegraph Stations

THERE are literally hundreds of commercial radio telegraph stations operating in the short-wave bands. A large portion of the world's communication takes place "in the spaces on your receiver dial" between the short-wave broadcast bands.

No doubt you have heard the rhythmic sounds of these transmitting stations and have had cause to wonder just what all the noise may amount to.

Communication links normally go into action only when there is traffic to be handled. Not so with the powerful radio telegraph transmitters; they pound away hour after hour irrespective of whether or not there are messages to be sent. The reasons for this continuous operation are many: For one thing, it costs more to shut down and start up a powerful transmitter than it does to keep it idling on the air. Moreover, when "cold," the frequency or wavelength of a transmitter is apt to shift; it is necessary, therefore, to keep the transmitter warmed up for instant use when traffic comes through over the land lines for overseas transmission. Furthermore, the receiving station in each country of the world maintaining service with the transmitter must be kept properly tuned to the station at all times. So long as the transmitter is in operation, the operator at each receiving position can keep a constant check on the signal.



Showing how constant radio telegraph communication is maintained

This rather peculiar manner of operation serves to maintain an almost foolproof service, ready for instant use at any time of day or night.

Of course, a single radio transmitter maintains schedules with a number of countries. A New York station may clear traffic with London one moment and with Buenos Aires the next moment. At the same time the transmitters at London and Buenos Aires may be clearing traffic with New York.

This form of operation is made possible through the use of separate transmitting wavelengths and separate receivers, one receiver for each transmitter in the link. Thus, as shown in the accompanying sketch, New York transmits to London and Buenos Aires on, say, 23 meters; London transmits to New York and Buenos Aires on 22 meters, and Buenos Aires transmits to London and New York on 21 meters. Furthermore, New York has receivers constantly tuned to London and Buenos Aires, and so on, with the result that, with no change whatsoever in wavelength, New York can cut short transmissions with London and immediately commence the transmission of traffic to Buenos Aires. At the same time, both London and Buenos Aires can be clearing traffic with New York.

Actual traffic is handled at high speed, and is entirely automatic. During intervals of no traffic, the automatic sending device sends out a continuous series of dots, or the device is made to repeat over and over again the call letters of the station preceded by the letters "abc" or the letter "v". It is quite impossible, therefore, for the London operator to tune his New York receiver by mistake to the signals from Buenos Aires—not that it would be apt to happen anyway.

Transmission Line Extension

MANY listeners seem to believe that the radio receiver should be placed as close to the aerial and ground connections as possible, but quite often such a location is inconvenient. There may have been some excuse for this assumption in the past, when long lead wires through rooms increased noise pick-up, but with the advent of the noise-reducing antenna system using a transmission line, the assumption is invalid.

There is no reason why you shouldn't

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

place your radio receiver where it will be convenient to tune. A slightly longer transmission line will not reduce signal strength or increase noise pick-up. For that matter, efficiency will not be reduced if the line is brought in through, say, a window, and run along the baseboards to the receiver in some other room.

METAL TUBES

THERE have been some nasty rumors relative to metal tubes, most of which hinged upon production difficulties which are now fairly well ironed out. With the exception of the 5Z4, which has been redesigned, and the 6A8, a few of which have developed trouble in service, the metal tubes are good.

Courtesy RCA Manufacturing Co., Inc.

Welding metal tube parts. In this powerful machine, Thyratron-timed currents on the order of 75,000 amperes weld the parts to form the air-tight containers for the units

Three metal-tube receivers have been put through their paces. On the broadcast band, these sets are the equal of receivers using the glass tubes; on the short-wave bands the metal-tube receivers certainly appear superior. In any event, the metal tube is not to be sneezed at. It is here to stay.

BRUTE-FORCE EXPERIMENT

A NEW approach to the transmission of short-wave radio telegraph signals over long distances will be tried by RCA on the completion of a new 200-kilowatt short-wave transmitter now under construction at the company's station at Rocky Point, Long Island.

By means of this tremendous short-wave power, which is 5 to 10 times the intensity usually employed by international communication, it is proposed to "battle the ionosphere with kilowatts" and over-ride certain natural obstacles which to date have limited the signal strength under abnormal conditions.

As explained in previous notes in this column, the ionosphere, or Kennelly-Heaviside layer, is an electrified region in the earth's outer atmosphere. Short-wave radio signals are reflected or refracted back and forth between this region and the earth in their passage around the globe. There are cycles in the daily conditions of the ionosphere which make it necessary to use several wavelengths for long-distance radio communication. There are also times of magnetic disturbances, when the turbulent condition of the ionosphere causes absorption and dispersion of the radio signals and consequently reduced signal strength at the receiver. It is then that even highly concentrated beams become least effective.

What the engineers expect to determine by means of the new 200-kilowatt transmitter is whether the hours of usefulness of one or more of the wave-bands used in long-range communication may not be lengthened and the effects of magnetic storms minimized by the use of increased power.

The new transmitter will be operated at first only on one wavelength, in the neighborhood of 28 meters, which is between two of the present international short-wave broadcast bands. This wave has been selected as the trial one which promises the greatest general serviceability. It is expected that when radio signals from this transmitter are hurled against the ionosphere the greater power will cause them to be reflected back even during less favorable hours of operation for that particular wavelength. Present-day commercial radio practice has been brought to a high degree of reliability by directive transmission. This new step by RCA looks toward further conquests of the ether by enabling transmission through severely disturbed periods.

ULTRA-SHORT-WAVE RIDDLES

NUMEROUS theories have been advanced with regard to the nature and the behavior of radio signals below five meters. It is assumed that signals of such high frequency behave much in the same manner as light waves, yet full proof of this assumption has not been obtained.

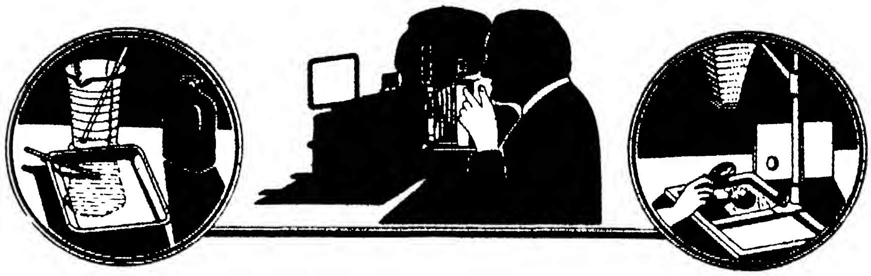
There is the supposition that the high-angle waves—those which are radiated upwards—are not sufficiently bent by the layers of the ionosphere to permit them to again return to earth. Presumably these waves are dissipated in outer space.

There are left the low-angle waves which, because of their similarity to light waves, are not perceptible beyond the optical horizon—at least presumably so.

In contradiction of the scant theories on the subject, signals transmitted on five meters are now consistently received over distances far beyond the optical horizon. Moreover, it cannot be said that there are definite limits to the distance an ultra-short-wave signal can cover.

It would seem that reception of these signals beyond the optical horizon is due to wave diffusion—after all, it is possible to see the beam of a powerful searchlight directed into the sky from a long distance off, because of light diffusion. But wave diffusion will not account for the reception of ultra-short-wave signals from a point hundreds of miles distant. In this case it would seem that some portion of the wave is reflected back to earth.

Once the nature of ultra-short radio waves is clearly understood, and more is known of their behavior, it may be possible to control them to a degree sufficient to permit their use for numerous services so far excluded from our over-crowded channels.



CAMERA ANGLES

Conducted by JACOB DESCHIN

Prints in Color

AND now prints in color—three colors, at that. The ingenuity of the men who burn the midnight oil to light the path to new discoveries in the photographic science has long been well known. But in view of the growing interest in color photography, few of these discoveries can equal the welcome accorded the advent of a new method by which any amateur may produce a three-color print from color-separation negatives within a half hour after fixing the three positives required for completion of a finished print.

This method is known as Chromatone, the discovery of two young New York chemists, Francis H. Snyder and Henry W. Rimbach, who developed it while hunting for a suitable way to produce color in photomicrographic work.

Success in turning out a color print by the Chromatone method depends entirely on the worker's fidelity to instructions furnished by the distributors, reasonable care in executing the various steps in the process, and thorough washing. That isn't asking any more than the cautious worker already gives his darkroom activities. Furthermore, there is nothing essentially new in the various steps of the Chromatone method; it is only the correlation of several known methods into an ingenious synthesis that is new.

The basis of the Chromatone process is the same as that which serves for three-color photography; namely, three color-separation negatives are taken, respectively, through blue, green, and red light filters. These negatives are used to make three contact or enlarged black and white positives on a special stripping film known as Chromatone Print Paper (a "double-weight" paper support for a collodion gelatine layer coated with an emulsion having approximately the speed of Azo No. 2). The collodion gelatine layers are "peeled" off while in the hypo and the three total in thickness, when dry, about 0.001 of an inch.

Each of these positives is then toned to its proper color—yellow, magenta and blue-green—and, while they are still wet, are superimposed in sharp register one over the other on a white paper base, using a rubber squeegee to force out the excess water. This constitutes the print and when dry it is trimmed to the size desired and mounted by the dry-mounting process.

Complete instructions for processing as well as a full discussion of color photography, illustrated with charts in color, are contained in a very comprehensive treatise which is furnished with a "kit" containing all the necessities for making Chromatone prints, as well as solutions and positive material for turning out eight 5 by 7 three-color prints. The booklet may also be purchased separately for a nominal sum so that the photographer who wishes to investigate the possibilities more thoroughly before making an investment may do so.

An advantage of the new color process lies in the fact that the original three color-separation negatives may be exposed in any camera and not necessarily, as hitherto, in the expensive "one-shot" professional outfits that cost as high as 1000 dollars and more. The only special equipment needed for taking the picture is three color filters, which are obtainable for as little as one dollar for the set. Another feature of the cost angle is that whereas hitherto a three-color job could be had for not less than 100 dollars and as high as several hundred dollars, the Chromatone process makes it possible to produce a three-color print in spectroscopically correct colors for from 60 cents to less than two dollars, depending on the size.

It seems fairly obvious that when taking a three-color picture in a camera other than the "one-shot" type, which exposes three negatives at once, persons as subjects are definitely "out" because of the danger that the subject may move slightly during the interval it takes to place another filter over the lens and bring a new film into place. Even so slight a movement as "a hair's breadth" would be enough to throw the thing off, since all three must be in perfect register if they are to line up in the final printing.

However, pending the appearance on the market of a reasonably inexpensive "one-shot" outfit selling for the price of a good ordinary camera, which, at the time of this writing, was already in the offing, pictures of persons as well as other subjects in which the probability of movement is a factor to be considered, are not necessarily "out of the picture." Of course, there is Dufaycolor or similar film, but their use as a medium for the Chromatone process involves an intermediate step. This lies in the photographing of the original in the usual way and then making three color-separation negatives of the projected transparent color positive. Messrs. Snyder and Rimbach suggest that three color-separation negatives of live models may easily be made on the miniature type of camera in less than five seconds for the complete set. Very nearly flat lighting is recommended for color photography.

If there were any doubts before, it is certainly safe to say now that color photography is here to stay. Nor is it, henceforth, to be the exclusive province of the few. It

is not hard to foresee picture albums filled with color and when baby next appears in print her red dress will be red, not a shade of gray, and her eyes sparkling the blue that Dad saw as he tripped the shutter.

Versatile Enlarger

A NEW accessory for the advanced amateur's darkroom, just announced, offers many desirable features in one complete and compact unit. Called the Enlarg-or-Printer, the device offers the photographer facilities for rapidly making enlargements or contact prints from negatives up to 2¼ by 3¼ or from sections of that size from

You can enlarge, print, or retouch with this new equipment

negatives up to four by five. Strip film can also be used, suitable adapters being provided. The device also can be converted into a retouching desk.

The accompanying illustration shows the Enlarg-or-Printer, together with its lens and a selection of negative masks. The light source is located in the base of the unit, and projects upward to the platen top which is of the automatic printer type. A Photo-flood bulb, in series with a ruby lamp, is automatically operated by the platen and a toggle switch provides a choice of two light intensities for varying requirements.

With this unit it is possible to turn out contact prints up to eight by ten at the usual speed. What is more important, however, from the standpoint of utility, it will turn out enlargements up to eight by ten just as fast and just as simply as it produces contact prints. With a wall easel it is possible to make enlargements of a size limited only by the quality of the negative.

The compactness of the equipment is remarkable, taking up a space only 11½ by 13¼ inches, and standing 26⅝ inches high overall. It weighs 21⅓ pounds.

Amateurs Score "Beats"

INSTANCES of amateur photographers who cash in on their hobby by being "on the spot" and getting the pictures before news-cameramen reach the scene come up often enough to make it worth the amateur's while to be always on the lookout for such opportunities. The recent tragic Will Rogers-Wiley Post crash in the Alaskan wilds provided such an opportunity for Dr. Henry Greist, missionary physician. Using a 3A Kodak with ordinary roll film and despite fog and rain he succeeded in making a series of exposures of the tragic scene long before professional photographers could reach the place. The films were flown via four changes of planes to San Francisco, where they were developed in the Associated Press darkrooms and then sent broadcast by the Wirephoto system.

Another case of a live-wire camera amateur was that of Ivan Dmitri, of New York City, one of the best known of the miniature camera enthusiasts, who made some shots of a big fire sometime ago and sold them to two metropolitan morning newspapers before their own men could get on the job. The pictures appeared on the front pages of the two newspapers the next morning.

The lesson to be learned here is that news cameramen cannot be everywhere and a picture "on the spot," even if made by a small box camera, is worth any number of the most excellent pictures taken after the event. Newspaper editors are always eager for this type of picture and will show their appreciation by paying well for your trouble.

Stick to One Clerk

THE advice often given to beginners in stamp collecting to cultivate some particular dealer because his fund of knowledge will save them from many pitfalls, is just as applicable in the case of the camera enthusiast. If the store is a large one and employs several clerks, pick one clerk and go to him for all your purchases. Dealer or clerk, either can be of tremendous help when it comes to solving some knotty picture-taking or darkroom problem, or when about to purchase additional equipment. The honest dealer or clerk, and most of them are that, is always ready to listen to your tale and give you sound advice, whether it means a sale or not. After all, he has everything to gain if you are successful and happy in your hobby, and certainly much to lose if you are not.

New 35-mm Film

THE Cappelli 35-mm film is now available in the United States after having achieved a reputation for speed and fine-grain excellence abroad. Packed in a daylight spool of 36 exposures, it has a Scheiner rating of 26° and is fully panchromatic.

Low-Priced Reflex

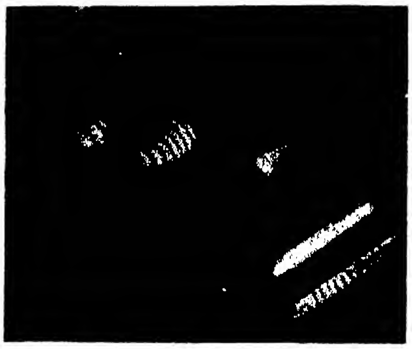
THE K. W. Reflex-Box, taking 2¼ by 3¼-inch roll-film, is the most recent addition to the reflex field. Not the least attractive of its features is the fact that it sells tor an unusually low price for a type of camera whose cost has hitherto made it prohibitive to modest purses. The self-erecting hood containing the focusing screen of ground glass, on which the subject is viewed as it will appear in the negative, is part of this equipment as it is of the more expensive ones in its field. Focusing is done by rotating the lens.

An all-metal slit shutter provides speeds of 1/25th, 1/50th and 1/100th second and for brief and long-time exposures. The camera weighs but two pounds and measures

4⅞ by 3⅛ by 4½ inches. There are two models, one equipped with an f/6.3 anastigmat lens, the other equipped with a Steinheil Actinar f/4.5 anastigmat, iris diaphragm, level, carrying strap, and cable release.

Shadow Patterns

PROJECTING a design in shadow on either subject or background is a popular method of gaining effects for unusual photographic interpretations. Two eggs become dramatic entities when a spotlight throws over them long shadows cast by a simple egg slicer; the netting in a tennis racket held over the face of a fair lady at high noon gives a beautiful effect. The most interesting results are to be had indoors with the use of a spotlight to throw the shadow of the design or object, although many odd and often startling impressions are frequently found outdoors under brilliant sunlight.



Light and shadow

Shadow patterns are created by interposing an irregular object or cardboard cut-out between the light source, whether solar or artificial light, and the area on which the shadows are to fall. The irregular object might be a vase, a pair of shears, a leaf, or it might be composed of lines, curves, or circles or other forms strung within a frame. Allowing of still wider manipulation is the projection cutout made of cardboard. Here the opportunities are unlimited, since the designer may even simulate a street scene within his home studio merely by making a cutout and projecting its shadow upon a light background.

Observation has taught that the nearer an object to the area on which its shadow is thrown the smaller will the shadow be, and the sharper its edges; the farther away, the bigger the shadow and less sharp. A spotlight, because of its concentrated power, will give a sharp edge, but a diffused light will not. For shadow patterns, therefore, particularly where objects are simulated by means of the projection cutout, the spotlight is preferable and in some cases indispensable.

35-mm Reversible Superpan

FOR users of cameras taking 35-mm film, an emulsion for getting direct positives which are developed by the reversal process (Agfa Reversible Superpan) may offer opportunities for new adventures. This film, which has a Scheiner rating of 20° in daylight, is suitable for viewing by transmitted light, for the making of paper negatives, or making larger negatives by direct projection.

THE SCIENTIFIC AMERICAN DIGEST

(Continued from page 325)

and the high proportion of cases in which the fracture heals with a good join.

The observations of tuberculosis and syphilis are subject to the fact that no soft parts are available for examination; but otherwise there is no appearance of tuberculosis in the paleolithic period, while in the neolithic, bronze, and iron ages cases are few. To a certain extent, there is uncertainty in the identification of the lesions of syphilis, but it would appear that there is no case of syphilis in paleolithic man, and in the later prehistoric periods only a very few cases from France and one from Russia appear certain.

Dental caries is not found in paleolithic man in Europe, but appears in Africa in men of (probably) late paleolithic age.—Adapted from *Nature* (London).

Cellophane Soda Straws

STRAWS of Cellophane in various colors, called Glassips, are the latest supplement to the current fashion of serving cool drinks in different colored glasses for parties and outings. Since they do not disintegrate in alcohol, they may be used for both hard and soft drinks. Absolutely tasteless and shape-retaining, they are ideal for the sick room. Children are delighted with them and find that drinking milk can be a pleasure.

VACATIONS

ACCORDING to a recent estimate, the American people spend 5,000,000,000 dollars in a normal year on holiday and vacation travel.

Gelatin Noses and Ears

NOSES, ears, or other facial features made of gelatin and applied with a mastic cement were described recently by Dr. Oscar V. Batson of Philadelphia at a meeting of the American Academy of Ophthalmology and Otolaryngology.

When the features have been destroyed by disease, accident, or curative measures to such a degree that the patient feels himself disfigured, it is the duty of the physician to remove if possible the stigma, fancied or real, Dr. Batson declared. Plastic surgical measures should be considered first in such cases, but if the vitality of the skin has been lowered, they may not succeed.

For such cases Dr. Batson advised the use of artificial features or prostheses, to use the medical term. He considers gelatin the most satisfactory substance because it is flexible, moves with the changing expression and can be attached without mechanical support. In a suitable patient, Dr. Batson said, the gelatin prostheses are not obvious to the observer at conversational distance.

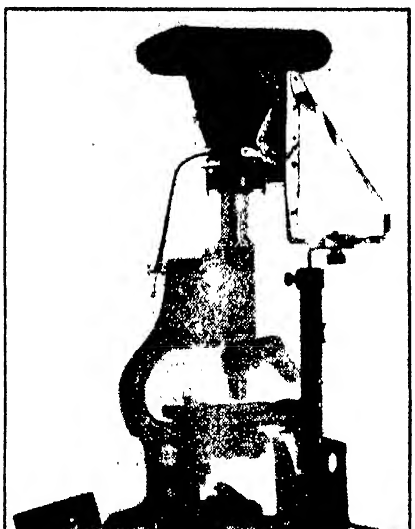
The gelatin artificial features are made by pouring gelatin, colored to match the skin, into molds made from wax models of the feature to be restored. They are held in place on the face with a mastic cement. The gelatin artificial features are of course temporary. Depending on the time of year and the character of the patient's skin, they last from one to ten days. However, the patient may be supplied with molds, suitably colored gelatin and cement, and can learn to make and apply his own feature as needed.—*Science Service.*

ROSIN

ROSIN production is said to be increased 100 percent by treating the wounds of the tapped trees with a solution of 25 percent hydrochloric acid. The balsam is not affected by the treatment.

Photomicrography Simplified by New Device

HERE'S news that should be welcome to every microscopist who takes his work seriously. A new device called the Microdak, makes it possible for any user of a microscope to make photographic records of his work without more than a casual



Simplified photomicrographic set-up

knowledge of amateur photography. Microdak is an Eastman development.

It is only necessary to focus the subject under the microscope properly, to place the Microdak in position, and to operate the shutter. Because the camera uses roll film, no darkroom is required, so photomicrographs can be made in any schoolroom or office. After exposure in the Microdak, the film can be developed and printed by any regular photo finisher or by the microscopist himself.

The Microdak is not a toy. It consists of a camera using $2\frac{1}{4}$ x$3\frac{1}{4}$ roll film, and having a fixed focus lens and a shutter with provisions for bulb and time exposures; a light-lock to shield the microscope eyepiece and camera lens; a bracket for holding the camera, a support for the camera

and bracket, which fastens to the stage of the microscope; and a counterweight that attaches to the microscope base. The phantom picture shows the Microdak attached to the microscope, ready for operation.

Etching Stainless Steel

A NEW method for etching stainless steel, prior to microscopic study of the grain structure, has been developed by the National Bureau of Standards.

All metals are composed of small, imperfect crystals known as grains, the size, shape, and structure of which are of great importance in the study of any metal and its application in service. To reveal this grain structure it is necessary to etch the metal with a chemical reagent. The appearance is then studied under the metallurgical microscope at suitable magnifications.

Certain metals are difficult to etch satisfactorily because of their compositions. Stainless steels are among the most troublesome, since they resist all ordinary reagents. In the past it has been necessary to use strong, mixed acids to reveal the structures of stainless steels, and these mixtures require great care in handling and in disposing of them afterwards.

The new method was worked out in connection with a study of the changes induced in stainless steels by welding. The stainless steel is etched electrolytically in oxalic acid (10 grams dissolved in 100 milliliters of water), the specimen being the anode and a piece of platinum the cathode. Current is supplied from four dry cells in series or from a 6-volt storage battery. The carbides are revealed in from 15 to 30 seconds' etching time, while an additional 30 to 45 seconds will reveal the grain boundaries of the "18-8" (18 percent chromium, 8 percent nickel) type of stainless steel. The solution is relatively rapid in etching action and does not stain the specimen.—*A. E. B.*

Transparent Operating Masks

NUMEROUS movies and stage productions have made everyone familiar with every detail of hospital operating rooms. It now appears that we will have to be re-educated, for the newest type of mask for operators is made of Plastacele—transparent and impermeable shields over the nose, mouth, and chin. These deflect the operator's breath backward and away from the patient and serve to protect the wearer against possible infection.

Among the advantages of these Maskons, as they are called, are feather-weight construction, quick adjustment, freedom from gagging, and easy cleaning, says the *Du Pont Magazine.* To put one on, the wearer simply adjusts the ear-loops or tapes and then presses the flexible aluminum rim at the top to fit the face. If the operator wears glasses, the snug fit on the upper part of the face keeps his breath from fogging them. This device also permits free breathing and speaking and eliminates nose and mouth pressure.

The latest in operating masks—made of Plastacele

LAMPS

AS an index of lighting progress, the American citizen consumes slightly more than five lamp bulbs per year. The next nation in the order of lamp usage is Denmark with about 1.75 lamp bulbs per person per year. Most European countries use about 1.5 lamps per person.

Egyptian Tomb Paintings

THE tombs of Egypt are a veritable encyclopaedia of the manners and customs of the ancient Egyptians. For many years Joseph Lindon Smith has spent part of each winter in Egypt where he has made paintings of details from the ancient tombs along the Nile. Karnak, Luxor, Sakkara, Thebes, and Giza, among other ancient sites, have provided material for his brush. Nor has he neglected the Nile landscape from the Sudan to Cairo.

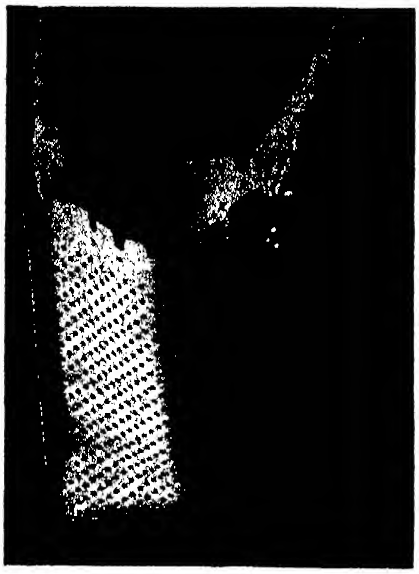
The Boston Museum of Fine Arts, of which Mr. Smith is Honorary Curator of Egyptian Art, has acquired over a period of years through the generosity of an anonymous friend, more than a hundred of his works. Seventy-eight of these are now in the Special Exhibition Galleries of the Museum. They are grouped according to source and arranged chronologically.

The paintings create an astonishing illusion of reality. One wishes to be reassured again and again that one is looking at a canvas and not a sculptured relief, notably in the group from the tomb of

Meresankh III. Figures in high relief represent various members of the family of Meresankh who accompany her through eternal life. Among them is her mother, the fair haired Hetep Heres, who appears to wear a smart gown with pointed shoulders. Other details indicate the food, clothing, and furniture used at the time, and the social customs prevailing.

Rubber Laundry Net

A RUBBER laundry net which is said to solve several of the more pressing problems of the industry has been produced by United States Rubber Products, Inc., after 18 months of experimental work in conjunction with the American Institute of



To save your clothes . . .

Laundering and with a further six months' collaboration with some 20 commercial laundries.

Laundry patrons have probably ruminated at one time or another on the problem a laundry faces in retaining the identity of the numerous shirts and pajamas dumped into its tubs in the course of a day's work. The secret of course is that they are not dumped into the tubs *en masse* but are placed in nets and washed in units.

This procedure has, in the past, given rise to a problem—each time the contents are washed the net is washed too. Laundry statisticians have figured that in the course of a year's time the average size laundry wastes seven or eight weeks washing and rewashing the old style nets. This problem has been solved by the development of a rubber net that will not wash with the clothes it holds.

Two other outstanding advantages of the rubber net are: (1) rubber nets do not burst and mix your clothes with those of your tub mates and, (2) the danger of tearing clothes while washing is considerably reduced.

Water-Soluble Resin

COMMERCIAL production has just been started on a new water-soluble "resin," Abopon. It is an odorless water-white liquid "resin" soluble in water but not soluble in any other liquid. It is a pure complex chemical compound and not a mixture. Abopon forms smooth, non-tacky, flexible, glossy

films. It is neutral and non-hygroscopic, spreads readily, and is more viscous and denser than glycerine. It is entirely inorganic, non-combustible, and is not affected by moderate amounts of strong acids or alkalies. It possesses strong adhesive properties.

Its indicated uses are as a suspending medium for pigments and abrasives and as a grinding medium for colors and pigments. As a wetting medium for pectin, gum tragacanth, gum karaya, and other water swelling materials, it prevents lumping and hastens dispersion. It serves as a sealer for surfaces which are to be lacquered or painted, and as a temporary coating for wares on display, to prevent soiling. This coating is washed off by the consumer, exposing a clean surface for use.

NEPTUNE'S METHANE

CALCULATIONS completed at the University of Michigan show that the outer layers alone of the atmosphere of Neptune contain six billion million tons of methane gas, which also forms a large portion of the natural gas found in the earth.

Progress of a Five-Year-Old Discovery

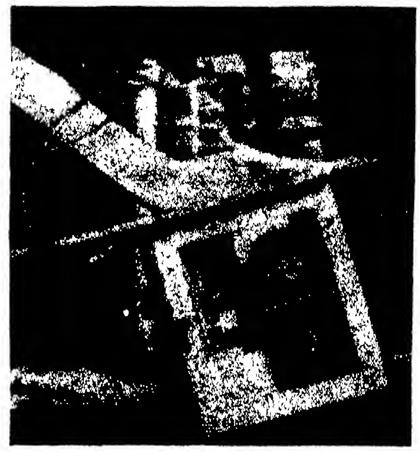
ABOUT five years ago, Scientific American reported the discovery of new non-toxic refrigerants, di- and tri-chlorodifluoromethane, by Thomas Midgley, of the General Motors Research Laboratories, and quoted the inventor's prediction that the application of these compounds to air-conditioning would result in greatly broadening the scope of this industry. Today that prediction has been verified. The total air-conditioning in use in the United States is now more than 16 times what it was in 1930.

Over 85 percent of all the mechanical refrigeration installed for air-conditioning since 1931 (when organic fluorides were first made commercially available) is operating on either dichlorodifluoromethane or trichlorodifluoromethane. At the present time 95 percent of all such new installations being made use one or the other of these refrigerants. Over 99 percent of all mechanical refrigeration in use on Pullman cars for air-conditioning employs dichlorodifluoromethane as the refrigerant.—*A. E. B.*

Slow-Motion Pictures Check "Rough Riding" of Trains

ABOUT a year ago, the Chicago, North Shore & Milwaukee Railroad, the high-speed electric line running between Chicago and Milwaukee, decided to conduct an investigation of truck oscillation or "nosing"—a transportation factor which, because of the resulting uncomfortable riding, has become increasingly objectionable on all railroads as speed has been increased.

A slow-motion 16-millimeter Bell & Howell motion picture camera was mounted in a box on a bracket on one corner of a truck which was guilty of nosing. Solenoid control started the camera after the car had reached a speed above 60 miles an hour, when noticeable nosing commences. The camera was focused on the lower part of the wheel where it contacts the rail, and pictures were taken of a worn wheel as found in service and then of a new replacement wheel. When the films were projected both the worn and the new wheel were seen to oscillate with a regular and continuous


The camera checks train riding

motion. The only difference noticeable in the movies of the two wheels was the less violent action of the new wheel due to the fact that this wheel had less clearance between flange and rail than did the worn one. This led to the belief that the oscillation was caused by the taper of one inch in 20 which has been a part of the standard design for railroad wheels.

On this belief, a set of wheels was turned without any taper but with the flange kept the same shape and size as formerly. Slow-motion pictures taken of these wheels showed no regular oscillation at all; in fact, the flange seldom impinged upon the rail on a straight track. The riding of the car was greatly improved, as there was no more nosing. The test car was put into regular service and watched as to wear of wheels and riding quality. The wheels wore with some taper due to the rails' being worn that way by the standard wheels, but slow-motion pictures taken after 30,000 miles showed only a slight tendency toward oscillation. This car is still in service and is being carefully watched, but the results of the test have been so conclusive that all new wheels and those re-turned are of the new type without a taper.

Says a Chicago, North Shore & Milwaukee Railroad official: "A number of railroad men from other lines have viewed the slow-motion pictures and have applied the principle to their equipment, especially in the case of the new streamlined trains; and greatly improved riding has resulted."

Platinum Thermometers

PLATINUM is extensively used in the chemical laboratory and is gradually finding new applications in the chemical factory. One of the interesting uses of platinum for measuring temperatures was described by F. E. Carter in *Industrial and Engineering Chemistry.*

"Chemical processes have usually to be carefully controlled as to temperature," says Mr. Carter, "and the platinum metals are much used in the indicating devices. In resistance thermometers, temperature is ob-

tained by measuring the resistance changes of the wire with the temperature. Pure platinum wire is generally used because of its stability and of its high temperature coefficient of resistance. The material must be of the highest purity, in which condition the coefficient is about 0.0039 per degree, Centigrade. Such thermometers are exceedingly accurate up to about 900 degrees, Centigrade, (1652 degrees, Fahrenheit). Above this temperature thermocouples must be used. Base-metal thermocouples have a high thermo-electromotive force but cannot be used satisfactorily much above 1000 degrees, Centigrade. For higher temperatures platinum metals are used. The negative element is pure platinum and the positive element is practically always an alloy of platinum and rhodium."—*A. E. B.*

SHRINKAGE FACTS

"WILL it shrink?" Most people want assurance when they buy a garment of any description, that it will still fit after it has been laundered or dry cleaned. Many manufacturers are trying to meet this demand for information by some sort of statement on the label attached to the garment. Unfortunately, many of the statements thus made are indefinite and almost worthless to the consumers, says the Federal Bureau of Home Economics.

What does "Preshrunk" or "Supershrunk" really tell you. Merely that the fabric has been subjected to a shrinking process. Will it shrink any more? You do not know. "Will not shrink out of fit" is a statement you sometimes find. It sounds more promising, but what does "out-of-fit" mean? Opinions vary. If it does shrink, the merchant's idea as to what constitutes "fit" is just as good as yours. "Fully shrunk" or "Will not shrink" can be rightly interpreted to mean that the garment will show no noticeable shrinkage when laundered.

The New York Board of Trade would go even farther. It recently initiated a project on shrinkage under the sponsorship of the American Standards Association. The committee working on the subject recommends that no woven fabric be labeled "Preshrunk" if it will shrink more than 3 percent when subjected to a standard washing procedure. In addition it recommends that the probable percentage of shrinkage be definitely given on the label, as "Preshrunk, will not shrink more than 2 percent." At present these recommendations have not been adopted by fabric finishers.

MAN, EXTINCT BISON, CO-EXISTENT IN AMERICA

NO doubt about it—there were hunters roaming the American wilderness so long ago that they slew animals unknown today.

A hand-made stone dart point has been discovered where it dealt its death blow—fixed in the vertebra of an extinct form of bison. The find clinches in the affirmative arguments that man inhabited America in those early days, perhaps 10,000 or 20,000 years ago.

The shot that paralyzed the hapless bison was discovered by Dr. Frank H. H. Roberts, Jr., of the Bureau of American Ethnology during recent excavations in northern Colorado. Dr. Roberts found the vertebra in an assortment of bison bones at a place where the ancient hunters butchered their game.—*Science Service.*

ENERGY FROM MATTER

(*Continued from page 301*)

an erg). The total energy released in the reaction in the motion of the two alpha particles is therefore twice this, or 27.4 microergs.

The energy put in as kinetic energy of the bombarding hydrogen ion is much smaller. The experiments can easily be done with voltages below 400,000, which means an energy of the bombarding ions of

$$\frac{400{,}000 \times 4.77 \times 10^{-10}}{300} = \text{ergs, or } 0.64 \text{ microergs.}$$

(The rule is: voltage times charge divided by 300 gives energy in ergs, and the charge, 4.77×10^{-10} is the same as for an electron.) Thus there is a *clear violation of conservation of energy*, for about 27.4 — 0.6 microergs of energy are gained for every transmutation taking place.

This may seem trivial when expressed per atom, but in view of the enormous number of lithium atoms in a pound (3.9×10^{25}) it is easily calculated that the conversion of a pound of lithium this way would give about 30,000,000 kilowatt-hours of energy, which is several million times the fuel value of petroleum. But the research of the type done so far is far from converting an appreciable quantity of material and, in view of the large energy used for protons which do not make a proper hit, the apparatus consumes vastly more energy than is released by atomic disintegration.

Now let us consider the exact masses. The precision measurements of these we owe to Aston of Cambridge, England, and to Bainbridge, now of Cambridge, Massachusetts. It is too long a story to describe here the details of the mass spectrographs in which a beam of ions is deflected in electric and magnetic fields to supply data from which the masses may be obtained. Suffice it to say that with this method the precise values of the masses involved in our discussion are found to be

H^1	1.0078
He^4	4.0022
Li^7	7.0146

Using these masses we find that the total mass of Li^7 and H^1 is 8.0224, whereas the mass of the two alpha particles given out by the reaction is 8.0044, so the *mass of the products is less than the mass of the atoms used by 0.0180 units.* The unit of mass here is such that the mass of the lighter oxygen isotope is taken to be exactly 16. It is known that unit mass on this scale is equal to 1.65×10^{-24} grams.

Therefore we are dealing in these experiments with a transformation in which the *total mass decreases by 2.97×10^{-26} grams and kinetic energy is gained by 26.8 microergs for every pair of alpha particles produced.* According to Einstein's principle this mass loss ought to correspond to 26.7 microergs, which is a perfect check.

As mentioned earlier, there are a number

of nuclear transmutations whose energies have been measured and found to involve mass changes accompanied by the equivalent energy changes. Neither the total mass nor the total energy is the same before and after the transmutation, but the sum of energy plus mass, multiplied by the square of the speed of light, remains unchanged. This we interpret as meaning that we have true conservation of energy if we count the mass changes as being equivalent to energy changes by the Einstein principle.

In a recent paper by Oliphant, Kempton and Rutherford, 15 different reactions are given, in which a quantitative correlation is established between the mass change and the energy change. So the validity of mass and energy equivalence is now fully established experimentally. But there is no hope of getting at this latent form of energy that is locked in matter until some more efficient way is found of stimulating the nuclear reactions by which it is released.

CURRENT BULLETIN BRIEFS

Wood Handbook is a well printed, 326-page book, paper covers, in which wood is defined in technical properties and behavior. The publication is of interest to wood users generally, embodying the results of 25 years of research by the Forest Products Laboratory. It treats of all practical uses of wood and is thoroughly illustrated with drawings and photographs. *Superintendent of Documents, Government Printing Office, Washington, D. C.—25 cents (coin).*

Blue Book of Thermometals is a 32-page loose-leaf bulletin which gives a comprehensive review of specifications, properties, and methods of application of modern thermostatic bi-metals. Ten full-page charts show flexion and force characteristics together with appropriate design formulas. *Write for Bulletin 1235A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

A Comprehensive Catalog of radio parts of particular interest to set constructors and service men is now available in a 40-page pamphlet which lists particularly molded and other types of insulating forms and panels. Specialized tools are also included. *Write for Bulletin 1235B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

Schneider Lenses for Photography and Cinema Work is an informative pamphlet, beautifully illustrated with photographs showing the type of work done with these particular lenses, and especially valuable to the advanced amateur photographer. *Write for Bulletin 1235C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

Skeet Handbook describes briefly the increasingly popular sport of skeet, shows how to lay out skeet fields, and gives valuable hints about skeet shooting. Thoroughly illustrated with excellent photographs and helpful drawings. Also included is "Macnab on Skeet," a little pamphlet which gives specific hints about shooting at the various positions, as well as generalized information. Both booklets will be sent upon request for *Bulletin 1235D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

Practically Everything in the way of radio supplies, ranging from soldering lugs all the way up to a 24-tube all-wave receiver, is included in a new 196-page radio catalog now available. *Write for Bulletin 1235E to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

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A Second Primer, by Samuel Crowther, is a broad discussion of economics as they pertain to the present situation in the United States and particularly in relationship to trade and tariffs. *The Chemical Foundation Incorporated, 654 Madison Avenue, New York City.—Gratis.*

Books SELECTED BY THE EDITORS

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By Alexis Carrel

IN this rather lengthy but readable book the famous French surgeon and biologist of the Rockefeller Institute sets down an immense amount of fact and philosophy regarding our bodies and minds and the activities of each. But his book is far from a mere catalog of physiological facts—it is mainly philosophical and is provocative. Dr. Carrel is a mystic—he also believes in telepathy and clairvoyance and this book presents his metaphysical leanings in general.—$3.65 postpaid.—*A. G. I.*

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By Vamba (Luigi Bertelli), Translated by Nicola Di Pietro

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By J. Reid Moir

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